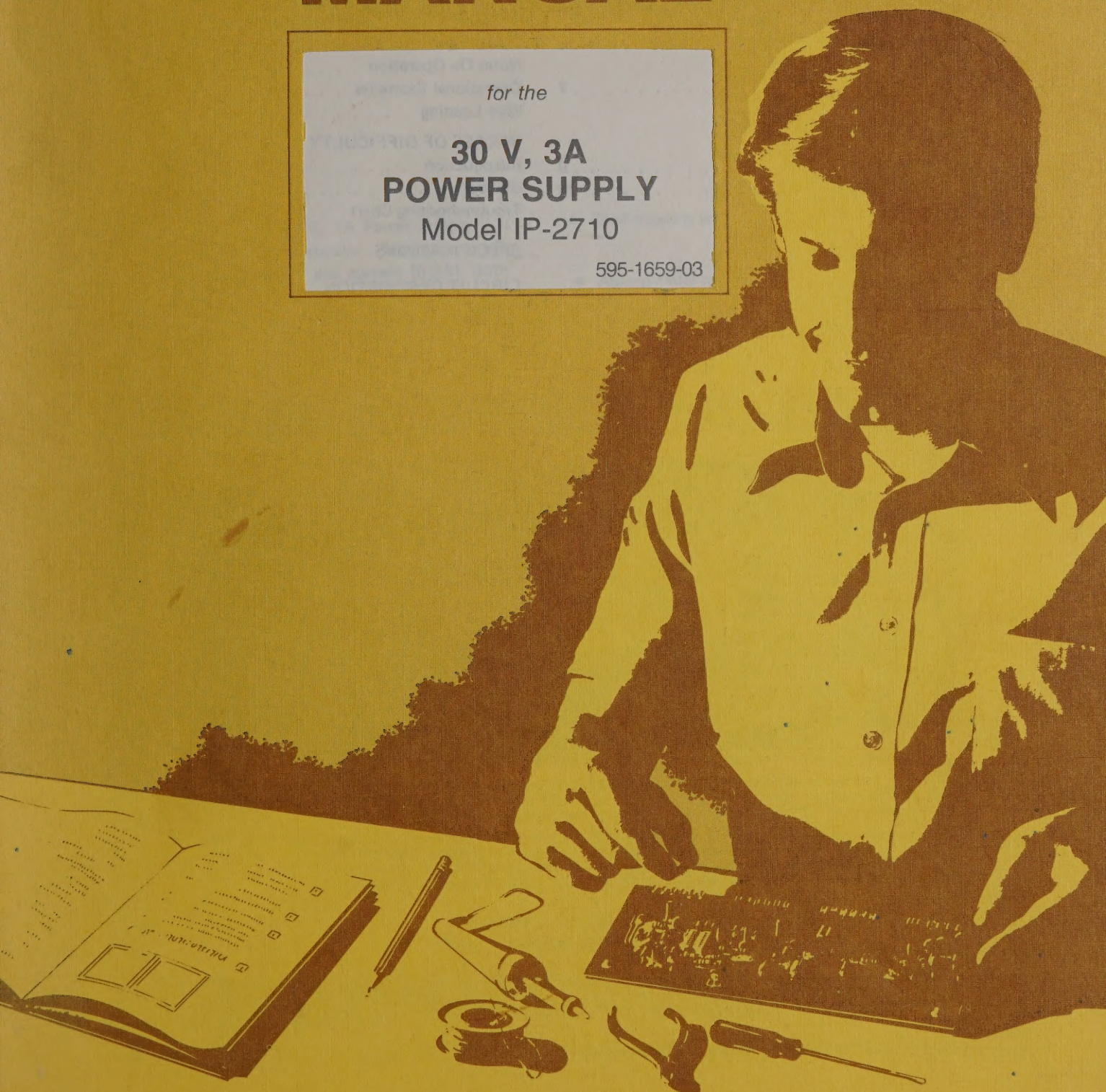
HEATHKIT®
MANUAL

for the

30 V, 3A
POWER SUPPLY
Model IP-2710

595-1659-03



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information ..... (616) 982-3411
Credit ..... (616) 982-3561
Replacement Parts ..... (616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only

R/C, Audio, and Electronic Organs ..... (616) 982-3310
Amateur Radio ..... (616) 982-3296
Test Equipment, Weather Instruments and
Home Clocks ..... (616) 982-3315
Television ..... (616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive,
Appliances and General Products ..... (616) 982-3496
Computers ..... (616) 982-3309

YOUR HEATHKIT 90 DAY LIMITED WARRANTY

If you are not satisfied with our service - warranty or otherwise - or with our products, write directly to our Director of Customer Services, Heath Company, Benton Harbor, Michigan 49022. He will make certain your problems receive immediate, personal attention.

Our attorney, who happens to be quite a kitbuilder himself, insists that we describe our warranty using all the necessary legal phrases in order to comply with the new warranty regulations. Fine. Here they are:

For a period of ninety (90) days after purchase, Heath Company will replace or repair free of charge any parts that are defective either in materials or workmanship. You can obtain parts directly from Heath Company by writing us at the address below or by telephoning us at (616) 982-3571. And we'll pay shipping charges to get those parts to you — anywhere in the world.

We warrant that during the first ninety (90) days after purchase, our products, when correctly assembled, calibrated, adjusted and used in accordance with our printed instructions, will meet published specifications.

If a defective part or error in design has caused your Heathkit product to malfunction during the warranty period through no fault of yours, we will service it free upon proof of purchase and delivery at your expense to the Heath factory, any Heathkit Electronic Center (units of Schlumberger Products Corporation), or any of our authorized overseas distributors.

You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

Our warranty does not cover and we are not responsible for damage caused by the use of corrosive solder, defective tools, incorrect assembly, misuse, fire, or by unauthorized modifications to or uses of our products for purposes other than as advertised. Our warranty does not include reimbursement for customer assembly or set-up time.

This warranty covers only Heathkit products and is not extended to allied equipment or components used in conjunction with our products. **We are not responsible for incidental or consequential damages**. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

HEATH COMPANY
BENTON HARBOR, MI. 49022

Prices and specifications subject to change without notice.

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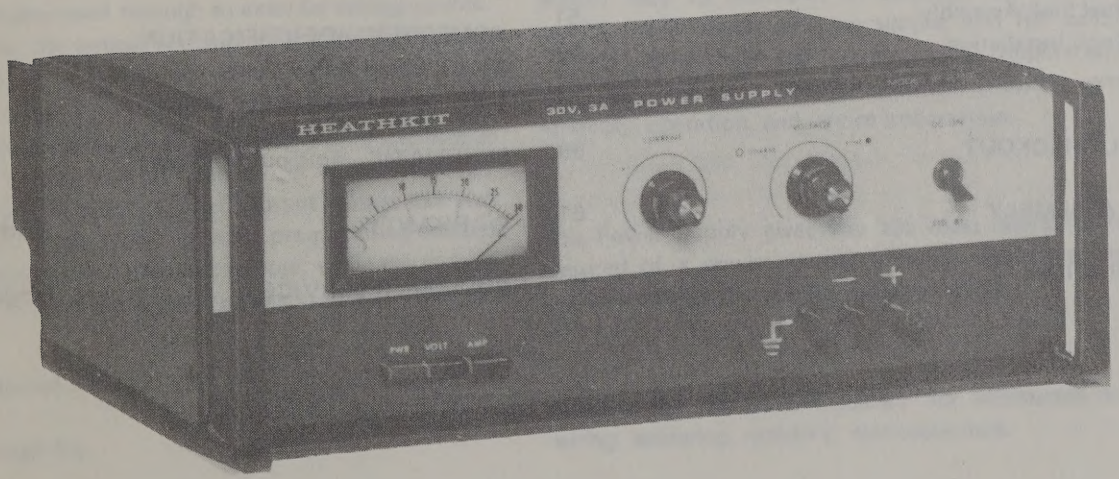

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit Model IP-2710 30V, 3A Power Supply is a precision instrument that provides laboratory-grade regulation of voltage (0-30 VDC) and current (0-3A). Both front and rear output terminals are isolated from chassis ground and thus can be referenced to supply either a positive or negative voltage, or allowed to float above ground. The large front panel meter can be switched to display load current or output voltage.

Load current limit is determined by a front panel control. It can also be programmed through an external voltage source. In either mode, the output is completely protected from a load short circuit.

Coarse and fine controls allow precise control of the output voltage level. In addition, this can be set while the Power Supply is in the Standby position. Output voltage can also be determined through two external programming modes. The first method uses a reference voltage; while the second requires only an external variable resistor.

Additional features include:

- Remote sensing.
- Auto-series operation.
- Dual-tracking with two Power Supplies.
- Auto-parallel operation.
- 120/240 AC power selectivity.

A wire harness and a printed circuit board make this Power Supply easy to assemble. In addition, open wiring and careful design make servicing simple, and full calibration requires only a single test resistor, that is supplied with this kit. The "famous" Heathkit Manual provides extensive assembly, operation, and service information.

This Power Supply gives you the most desirable features required of a power source, while its solid-state circuitry provides stablility, versatility, and reliability.

Refer to the "Kit Builders Guide" for information on tools, wiring, soldering, resistors, and capacitors.

KEEP THIS PARTS LIST WITH YOUR MANUAL AND USE THE PRICES SHOWN BELOW (DISREGARD ANY PRICES SHOWN IN YOUR MANUAL) WHEN ORDERING PARTS. THESE PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

PART NUMBER	PRICE	PART NUMBER	PRICE	PART NUMBER	PRICE	PART NUMBER	PRICE
6- 100	.25	252- 3	.05				
6- 101-12	.25	253- 60	.05				
6- 102-12	.25	254- 1	.05				
6- 103-12	.25	260- 89	.15				
6- 104-12	.25	260- 90	.05				
6- 150-12	.25	305- 65	3.65				
6- 220	.25	344- 90	.05@				
6- 222-12	.25	344- 92	.05@				
6- 224-12	.25	344- 99	.05@				
6- 330-12	.25	346- 4	.15@				
6- 471-12	.25	354- 5	.15				
6- 472-12	.25	354- 8	.15				
6- 474-12	.25	390-1450	.60				
6- 479	.25	391- 34	.20				
6- 681	.25	401- 202	3.15				
6- 682-12	.25	412- 611	.90				
10- 387	.75	417- 235	.55				
10- 392	1.10	417- 801	.45				
10-1126	1.20	417- 818	1.30				
20- 121	.60	434- 298	.30				
20- 177	.50	442- 610	2.75				
21- 16	.25	442- 654	2.20				
21- 22	.25	442- 917	1.20				
21- 36	.25	462-1044	.90				
21- 99	.45	490- 5	.25				
21- 143	.35	490- 109	.25				
21- 163	.30	490- 111	.15				
21- 171	.25						
21- 199	.40						
25- 116	.75						
25- 149	.75						
25- 241	1.55						
25- 248	.60						
25- 839	.55						
27- 28	.60						
27- 79	.35						
27- 85	.50						
27- 129	.40						
27- 137	.35						
40-1033	2.70						
54- 276	5.35						
56- 32	.60						
56- 56	.55						
57- 65	.40						
64- 855	3.25						
64- 856	3.15						
73- 92	.25						
75- 138	.15						
75- 203	.95						
75- 715	.15						
85-2067- 1	3.60						
89- 49	1.05						
95- 634	6.50						
95- 637	3.00						
204-2330	1.30						
250- 89	.05						
250- 347	.05						
250- 354	.05						
250- 559	.10						
250- 592	.05						

ADDITIONAL 3' ROLLS OF SOLDER, #331-6, CAN BE ORDERED FOR 25 CENTS EACH.

The prices shown on the "Heath Parts Price List" apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering (Michigan residents add 4% sales tax) to cover insurance, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

***** WRITE HEATH COMPANY FOR PRICE INFORMATION.
@ PRICE PER FOOT.

HEATH
Schlumberger

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

IMPORTANT INFORMATION regarding the resistors in your kit.

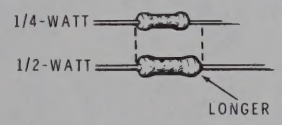
Carbon film resistors have been supplied with your kit in place of many of the carbon composition resistors previously used. Although carbon composition resistors may still be illustrated in your Manual, the values, color codes and installation of these components remain the same.

However, there are three important facts you should remember:

1. **All carbon film resistors supplied with your kit have a tolerance of 5%.** You can use them in any assembly step which calls for 5% or 10% tolerance resistors.

2. Carbon film resistors have a greater heat dissipating ability for their physical size than carbon composition resistors.

3. **1/2-watt carbon film resistors may nearly be the same physical size as 1/4-watt carbon film resistors** However, side-by-side comparison will identify the larger wattage resistor as having the slightly longer body length.

composition  **film** 

Thank you,

HEATH COMPANY

HEATHKIT® P-0

GENERAL
591-2361

HEATH
Schlumberger

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

IMPORTANT NOTICE

Please make the following changes in your Manual before you start to assemble the kit.

Page 10 — Under "Capacitors."

Change:	( ) 3	.01 μF ceramic	21-172	C112, C116, C121
To:	( ) 4	.01 μF ceramic	21-172	C112, C116, C121, C142

Page 12 — Under "Parts From Final Pack."

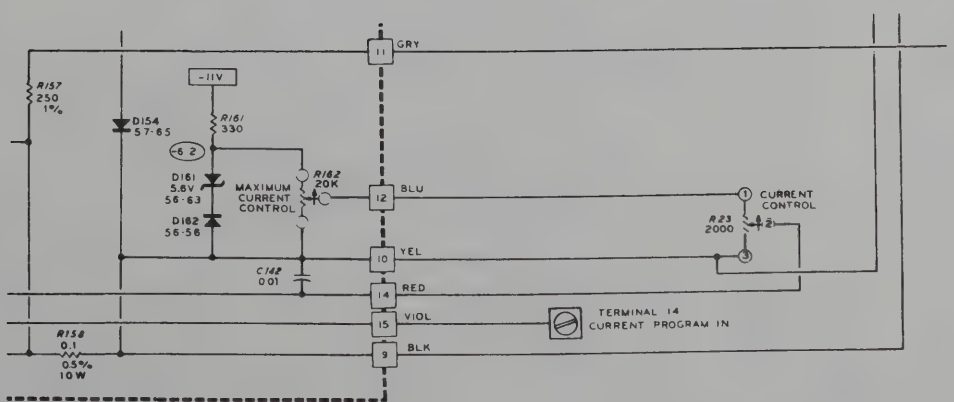
Change:	( ) 1	Circuit board	85-1449-3
To:	( ) 1	Circuit board	85-1804-1

Page 17 — Tape the new Page 17 (attached to this Notice) over Page 17 in your Manual.

Schematic — Cut out the revised partial schematic below, and tape it over the matching portion of the schematic in your Manual.

Thank you,

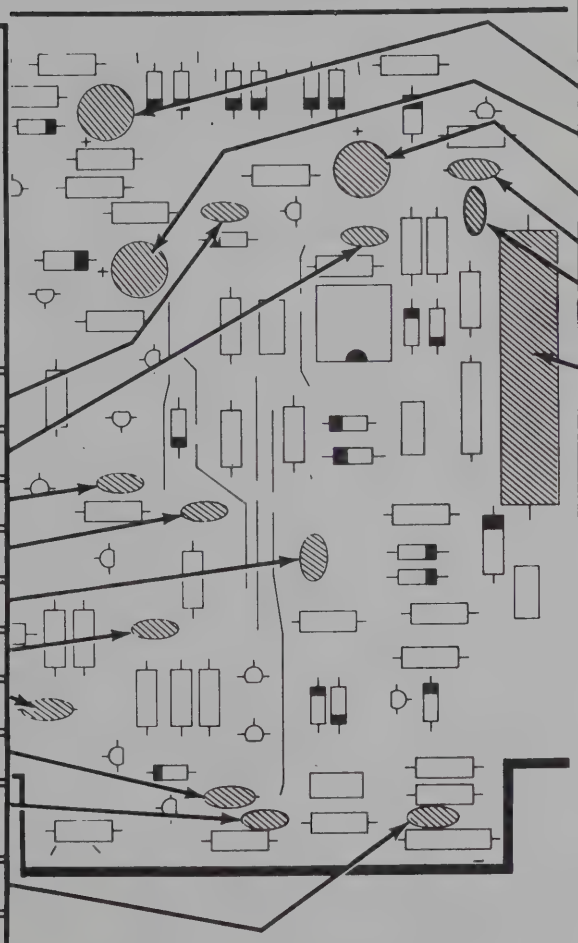
HEATH COMPANY



IDENTIFICATION DRAWING

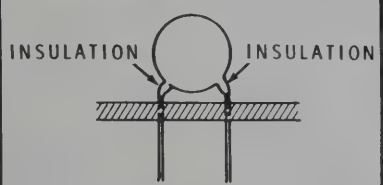
PART NUMBER

The steps performed in this Pictorial are in this area of the circuit board.



START

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C116: .01 μF ceramic. . . . . .

( ) C152: 680 pF ceramic. . . . . .

( ) C151: 27 pF ceramic. . . . . .

( ) C121: .01 μF ceramic. . . . . .

( ) C112: .01 μF ceramic. . . . . .

( ) C128: 200 pF ceramic. . . . . .

( ) C126: 2200 pF (.0022 μF) ceramic.

( ) C122: 2200 pF (.0022 μF) ceramic.

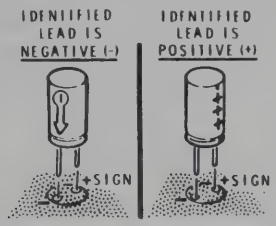
( ) C129: 24 pF ceramic. NOTE: Value not marked on circuit board.

( ) C141: 100 pF ceramic. . . . . .

( ) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

NOTE: When you install electrolytic capacitors, always match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.



( ) C101: 100 μF electrolytic.

( ) C111: 100 μF electrolytic.

( ) C115: 100 μF electrolytic.

( ) C117: 4700 pF (.0047 μF) ceramic.

( ) C142: .01 μF ceramic.

( ) R158: .1 Ω, .5%, 10-watt precision. NOTE: Be sure to form a good uniform solder connection around each lead of this resistor.

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-5

UNPACKING INSTRUCTIONS

DO NOT UNPACK YOUR POWER SUPPLY PARTS UNTIL YOU ARE INSTRUCTED TO DO SO.

Inside the shipping carton for your Power Supply is a large carton. This carton contains a number of small boxes and loose parts. Beneath the large carton and a cardboard separator are the remaining parts for your kit.

You will assemble your kit in two sections. The first section will be "Circuit Board Assembly," and the second will be "Chassis Assembly." Study the "Kit Builders Guide" located in the large carton before you begin assembly.

The circuit board parts are called "Pack #1," and are packed:

A. In a small box inside the large carton. This box of parts is labeled "PK #1."

B. Beneath the large carton and cardboard separator in a small envelope marked "Part of PK #1."

All of the remaining parts in the shipping carton and large carton are considered the "Final Pack." These will be used to assemble the chassis.

Each assembly section has its own Parts List. Do not unpack parts until you are told to do so in a Parts List.

When you check parts against a Parts List, return any part or group of parts that is packaged in a bag or envelope, with a part number, to its container after you identify it. Leave it there until you actually use it in a step. This will prevent intermixing of parts and aid in part identification. Some parts, however, have been placed in a bag or envelope that is not marked with the actual part number, but with a packaging number that begins with the number "171-" or "172-". These numbers are used for packaging purposes only and do not appear in the Manual Parts Lists. Open each bag or envelope that is marked with only a "171-" or "172-" packaging number to identify the parts it contains.

Save all packaging material until you locate all the parts, or until you have finished the assembly of the Power Supply.

NOTE: Never use a "171-" or "172-" packaging number if you must order a replacement part. Use only the part numbers listed in the Manual Parts Lists for this purpose.

ASSEMBLY NOTES

Before you start to assemble this kit, be sure you have read the wiring and soldering information in the "Kit Builders Guide."

Follow the Manual instructions carefully, and read the entire step before you perform the operation. Position all parts as shown in the illustrations. These illustrations are called pictorials and details. Pictorials show the overall operation for a group of assembly steps; details generally illustrate a single step. When you are directed to refer to a certain pictorial "for the following steps," continue to use that pictorial until you are referred to another pictorial for another group of steps.

Due to the small foil area around the circuit board holes and small areas between foils, it will be necessary to use the utmost care to prevent solder bridges from forming between adjacent foil areas. A solder bridge may occur if you accidentally touch an adjacent, previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: Always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will flow onto the tip of the soldering iron and remove the solder bridge.

Do not heat components excessively with the soldering iron. Diodes, transistors, integrated circuits, etc., can be damaged if subjected to excessive amounts of heat. Use no larger than a 25-watt soldering iron with a small tip. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection. NOTE: A number of connections in this kit will require a high amount of heat to produce a good solder connection. Where the use of a large soldering iron or soldering gun (if available) is needed, the solder step will tell you.

Resistors will be called out by their resistance value in Ω, kΩ, or MΩ, and color code, if the resistor is color coded. Use 1/2-watt resistors unless directed otherwise.

Capacitors will be called out by their capacitance value (in pF or μF) and type (ceramic, Mylar*, electrolytic, etc.).

Each circuit part in this kit has its own "Circuit Component Number" (R2, C11, Q1, etc.). This is a specific number for only that one part. The purpose of these numbers is to help you easily identify the same part in each section of this Manual. These numbers will appear:

- In the Parts List;
- At the beginning of each step where a component is installed;
- In some illustrations;
- In the sections at the rear of the Manual;
- In the Schematic.

*DuPont Registered Trademark

CIRCUIT BOARD ASSEMBLY

PARTS LIST

Remove only the parts labeled Pack #1 from the shipping carton and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packaged in an individual envelope with a part number on it should be placed back in the envelope after you identify it, until it is called for in a step.

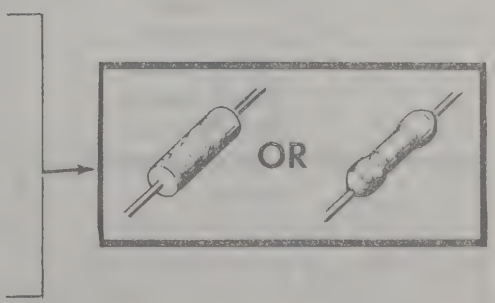
To order a replacement part, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of the Manual. For pricing information, refer to the separate "Heath Parts Price List."

QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.

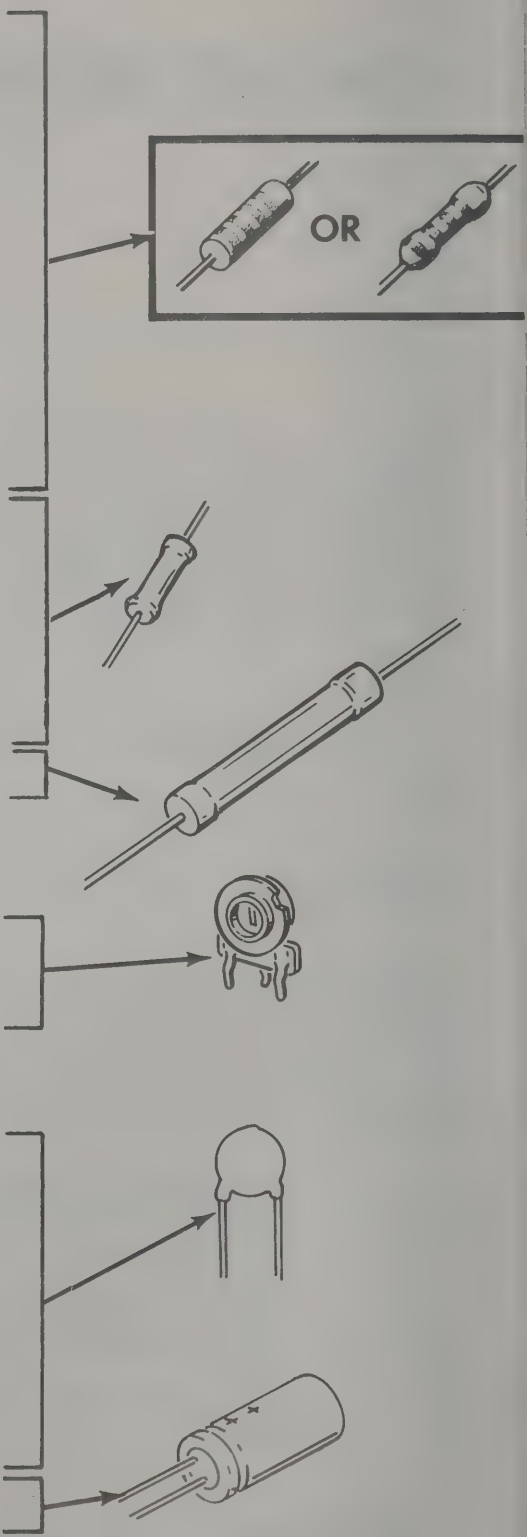
RESISTORS

NOTE: These resistors may be packed in more than one envelope. Open all the resistor envelopes in this pack before you check them against the Parts List. All resistors are 5%, 1/2-watt unless otherwise specified. 5% resistors have a gold fourth color band, 10% resistors have a silver fourth color band, and precision resistors are not color coded.

( )	1	47 Ω (yellow-violet-black)	1-145	R101
( )	1	75 Ω (violet-green-black)	1-146	R121
( )	1	150 Ω, 10% (brown-green-brown)	1-66	R126
( )	1	220 Ω (red-red-brown)	1-147	R112
( )	3	330 Ω (orange-orange-brown)	1-151	R103, R128, R161
( )	3	470 Ω (yellow-violet-brown)	1-157	R119, R129, R131



	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
RESISTORS (Cont'd.)				
( )	5	680 Ω (blue-gray-brown)	1-52	R102, R104, R117, R122, R124
( )	1	1800 Ω (brown-gray-red)	1-144	R138
( )	2	2400 Ω (red-yellow-red)	1-89	R155, R156
( )	1	2700 Ω (red-violet-red)	1-158	R115
( )	3	4700 Ω (yellow-violet-red)	1-43	R136, R137, R139
( )	2	6800 Ω (blue-gray-red)	1-51	R133, R134
( )	2	8200 Ω (gray-red-red)	1-114	R118, R123
( )	3	15 kΩ (brown-green-orange)	1-133	R111, R127 R151
( )	1	22 kΩ (red-red-orange)	1-58	R159
( )	2	2.2 MΩ, 10% (red-red-green)	1-37	R153, R154
( )	1	250 Ω, 1% precision	2-140	R157
( )	1	845 Ω, 1%, 1/4-watt 25 PPM/C precision	2-3-12	R113
( )	1	2000 Ω (2k Ω), 1% 1/4-watt; 100 PPM/C precision	2-60-12	R143
( )	1	10 kΩ, 1%, 1/4-watt, 100 PPM/C precision	2-66-12	R142
( )	1	0.1 Ω, .5%, 10-watt precision	3-38-10	R158
CONTROLS				
( )	1	200 Ω	10-917	R135
( )	1	5000 Ω (5 k)	10-904	R114
( )	2	20 kΩ	10-390	R116, R162
( )	1	500 kΩ	10-946	R152
CAPACITORS				
( )	1	24 pF ceramic	21-84	C129
( )	1	27 pF ceramic	21-6	C151
( )	1	100 pF ceramic	21-9	C141
( )	1	200 pF ceramic	21-21	C128
( )	1	680 pF ceramic	21-171	C152
( )	2	2200 pF (.0022 μF) ceramic	21-173	C122, C126
( )	1	4700 pF (.0047 μF) ceramic	21-144	C117
( )	3	.01 μF ceramic	21-176	C112, C116, C121
( )	3	100 μF electrolytic	25-248	C101, C111, C115



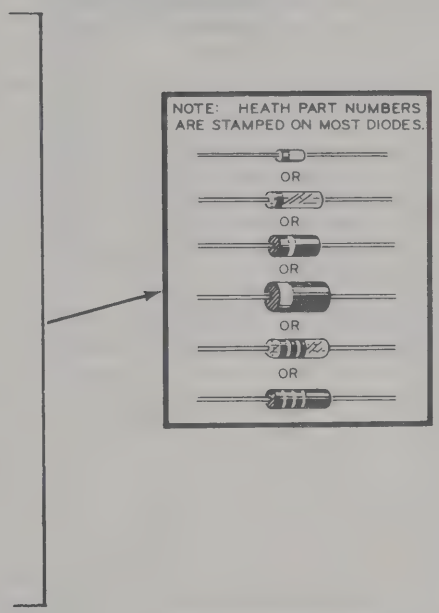
	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.

DIODES-TRANSISTORS-INTEGRATED CIRCUIT

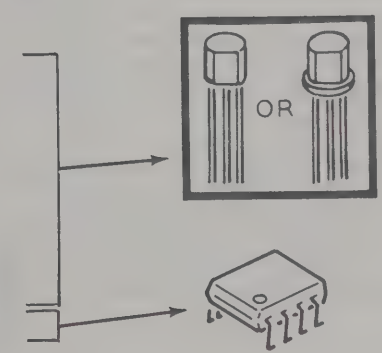
NOTE: Diodes, transistors, and integrated circuits are marked for identification in one of the following four ways.

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

( )	7	1N4149 diode	56-56	D121, D122, D123, D151, D152, D153, D162
( )	2	1N716A, (violet-brown-blue) 12-volt zener diode	56-57	D114, D118
( )	1	1N709A, (violet-black-white) 6.2-volt zener diode	56-58	D103
( )	1	1N750A, (violet-green-black) 4.7-volt zener diode	56-59	D113
( )	3	MZ500-10, 5.6-volt zener diode	56-63	D119, D131, D161
( )	1	1N825A, 6.2-volt temperature compensated zener diode	56-71	D115
( )	7	1N4002 diode	57-65	D101, D102, D111, D112, D116, D117, D154

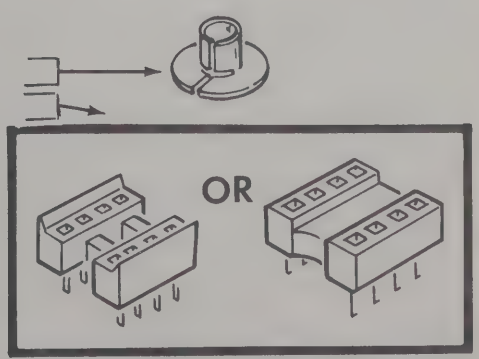


( )	1	Matched transistor pair	117-12	Q110, Q111
( )	5	X29A829 transistor	417-201	Q102, Q104, Q105, Q108, Q109
( )	3	MPSA42 transistor	417-294	Q106, Q107, Q113
( )	1	MPSL51 transistor	417-295	Q101
( )	2	MPSA20 transistor	417-801	Q103, Q112
( )	1	741 Integrated circuit	442-22	IC101



MISCELLANEOUS PARTS

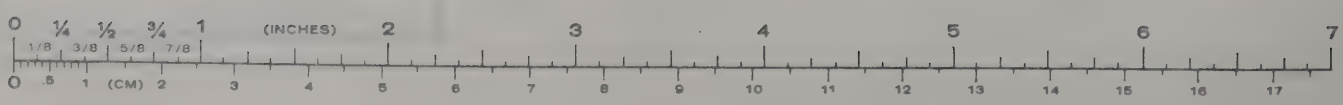
( )	4	Heat sink	215-84	
( )	1	8-pin socket	434-230	



QTY.	DESCRIPTION	HEATH Part No.

PARTS FROM FINAL PACK

( )	1	Circuit board	85-1449-3
( )	18"	Red solid wire	344-52
( )	1	Parts Order Form	597-260
( )	1	Kit Builders Guide	597-308
( )	1	Assembly Manual (See Page 1 for part number.)	
		Solder	



STEP-BY-STEP ASSEMBLY

START

Position the circuit board lettered-side-up as shown. Then perform the steps on each page.

NOTE: When you install a diode, always match the banded end of the diode with the band mark on the circuit board. Refer to Detail 1-1A to identify the banded end.

( ) D103: 1N709A (violet-black-white) diode (#56-58).

( ) D118: 1N716A (violet-brown-blue) diode (#56-57).

( ) D113: 1N750A (violet-green-black) diode (#56-59).

NOTE: To prepare a wire for the following steps, cut the wire to the indicated length and remove 1/4" of insulation from each end.

( ) 1-3/8" red wire. . . . . .

( ) 1-3/4" red wire. . . . . .

( ) 2-1/8" red wire. . . . . .

( ) 2-1/8" red wire. . . . . .

( ) 3" red wire. . . . . .

NOTE: Save the remaining wire for use in the chassis assembly.

Install three 1N4149 diodes (#56-56) as follows:

( ) D121. . . . . .

( ) D122. . . . . .

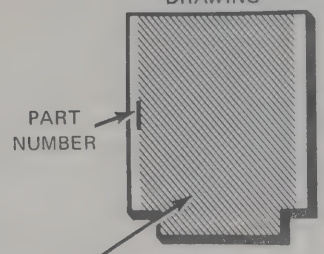
( ) D123. . . . . .

FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

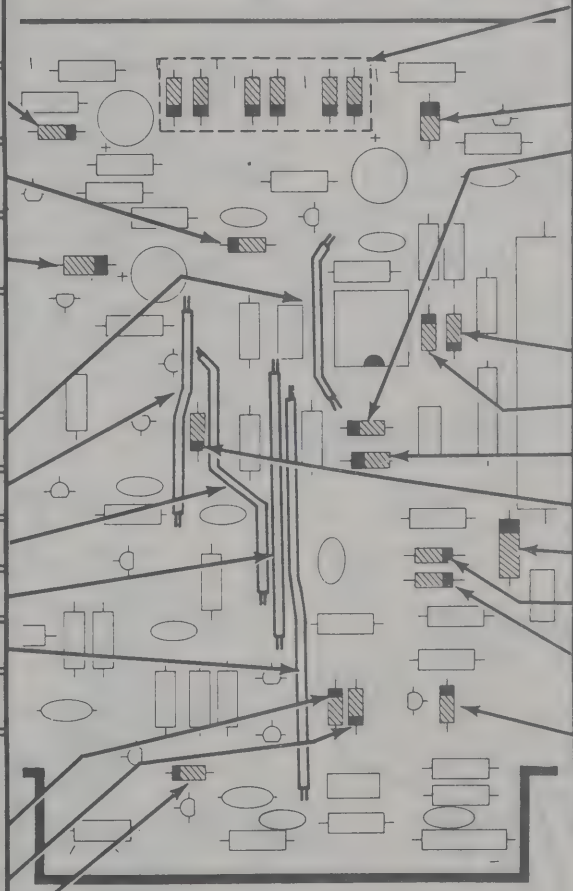
SAFETY WARNING: Avoid eye injury when you clip off excess leads. Hold the leads so they can not fly toward your eyes.

( ) Solder the leads to the foil and cut off the excess lead lengths.

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.



PICTORIAL 1-1

CONTINUE

Install six 1N4002 diodes (#57-65) as follows:

( ) D102, D101, D112, D116, D117, and D111.

( ) D119: MZ500 diode (#56-63).

( ) D161: MZ500 diode (#56-63).

( ) Solder the leads to the foil and cut off the excess lead lengths.

Install four 1N4149 diodes (#56-56) as follows:

( ) D152.

( ) D153.

( ) D162.

( ) D151.

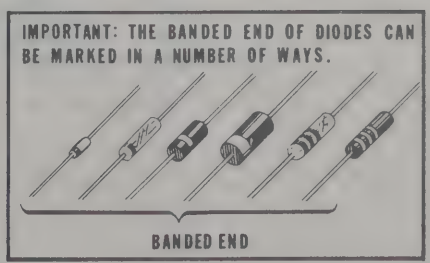
( ) D154: 1N4002 diode (#57-65).

( ) D115: 1N825A diode (#56-71).

( ) D114: 1N716A (violet-brown-blue) diode (#56-57).

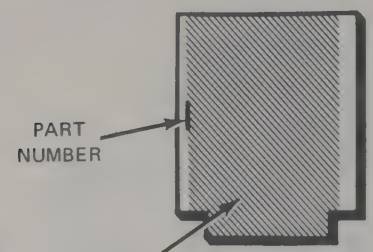
( ) D131: MZ500 diode (#56-63).

( ) Solder the leads to the foil and cut off the excess lead lengths.



Detail 1-1A

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

- ( ) R101: 47 Ω (yellow-violet-black).
- ( ) R104: 680 Ω (blue-gray-brown).
- ( ) R103: 330 Ω (orange-orange-brown).
- ( ) R102: 680 Ω (blue-gray-brown).
- ( ) R111: 15 kΩ (brown-green-orange).
- ( ) R153: 2.2 MΩ (red-red-green).
- ( ) R112: 220 Ω (red-red-brown).
- ( ) R115: 2700 Ω (red-violet-red).
- ( ) R151: 15 kΩ (brown-green-orange).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) R121: 75 Ω (violet-green-black).
- ( ) R128: 330 Ω (orange-orange-brown).
- ( ) R126: 150 Ω (brown-green-brown).
- ( ) R123: 8200 Ω (gray-red-red).

NOTE: Be sure to install 680 Ω (blue-gray-brown) resistors in the next two steps.

- ( ) R122: 680 Ω (blue-gray-brown).
- ( ) R124: 680 Ω (blue-gray-brown).

NOTE: Be sure to install 6800 Ω (blue-gray-red) resistors in the next two steps.

- ( ) R133: 6800 Ω (blue-gray-red).
- ( ) R134: 6800 Ω (blue-gray-red).
- ( ) R129: 470 Ω (yellow-violet-brown).
- ( ) R127: 15 kΩ (brown-green-orange).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

CONTINUE

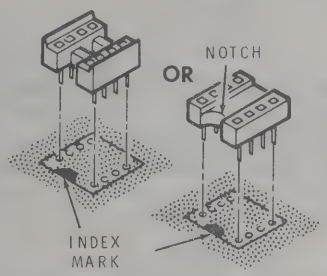
- ( ) R118: 8200 Ω (gray-red-red).
- ( ) R117: 680 Ω (blue-gray-brown).
- ( ) R154: 2.2 MΩ (red-red-green).
- ( ) R119: 470 Ω (yellow-violet-brown).
- ( ) R156: 2400 Ω (red-yellow-red).
- ( ) R159: 22 kΩ (red-red-orange).
- ( ) R155: 2400 Ω (red-yellow-red).
- ( ) R161: 330 Ω (orange-orange-brown).
- ( ) R157: 250 Ω, 1% precision. NOTE: Value not marked on circuit board.
- ( ) Solder the leads to the foil and cut off the excess lead lengths.
- ( ) R113: 845 Ω, 1% precision.
- ( ) R131: 470 Ω (yellow-violet-brown).
- ( ) R137: 4700 Ω (yellow-violet-red).
- ( ) R136: 4700 Ω (yellow-violet-red).
- ( ) R138: 1800 Ω (brown-gray-red).
- ( ) R143: 2000 Ω (2k), 1% precision.
- ( ) R142: 10 kΩ, 1% precision. NOTE: Value not marked on circuit board. board.
- ( ) R139: 4700 Ω (yellow-violet-red).
- ( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-2

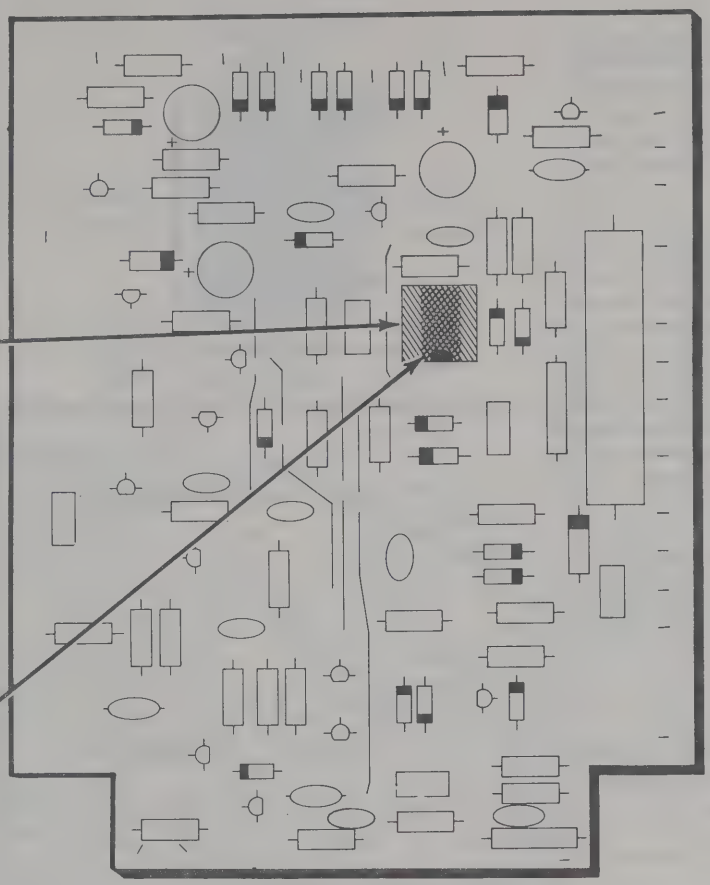
START

( ) 8-pin IC socket at IC101 as follows:

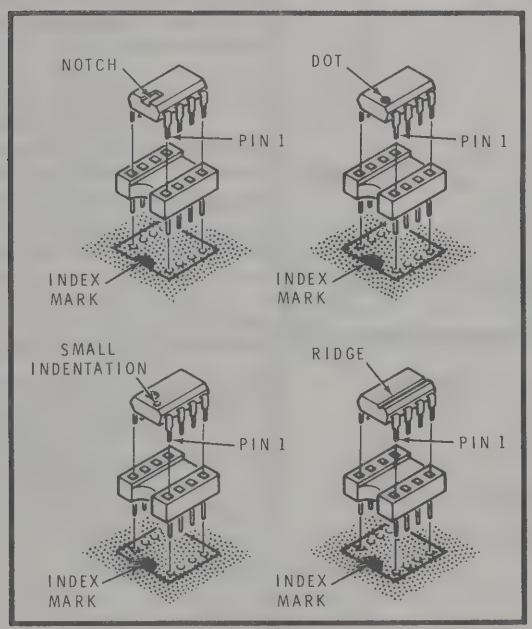
Be sure the socket pins are straight. Insert the socket pins into the holes. The index mark on the circuit board should still be visible after it is installed. Solder the pins to the foil. Make sure the bare jumper wires under the sockets do not touch any of the socket pins.



( ) IC101: 741 integrated circuit (#442-22). Refer to Detail 1-3A and identify pin 1. Then position the pin 1 end toward the index mark on the circuit board.

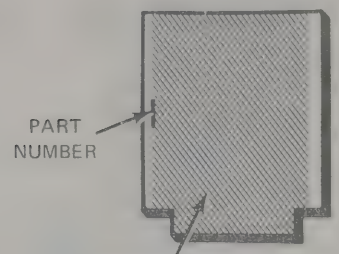


PICTORIAL 1-3



Detail 1-3A

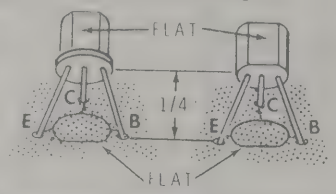
IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: Install the following transistors in the manner shown. First bend the center lead away from the flat, and line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes which are indicated by E, C, and B on the circuit board. Solder each lead to the foil and cut off the excess lead length.



The transistor case may be shaped like either one shown above.

Install five X29A829 transistors (#417-201) as follows:

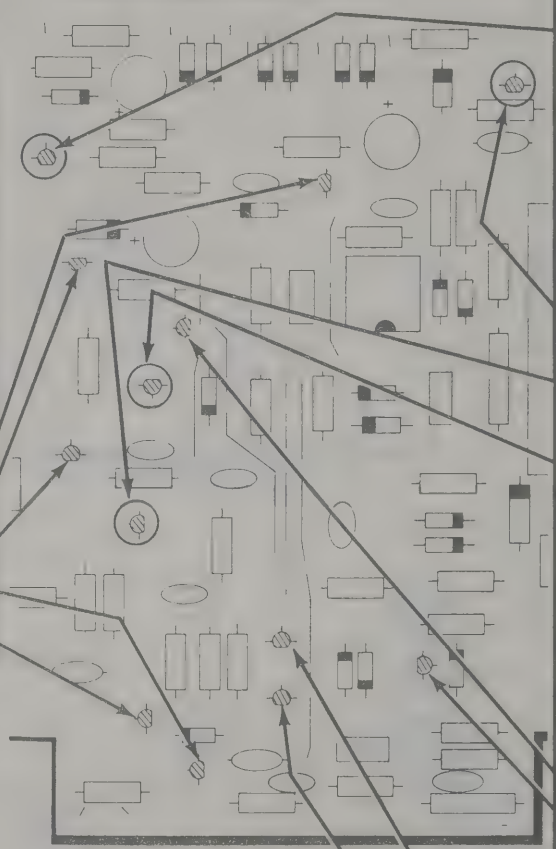
( ) Q105. . . . . .

( ) Q102. . . . . .

( ) Q104. . . . . .

( ) Q108. . . . . .

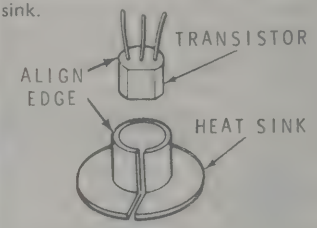
( ) Q109. . . . . .



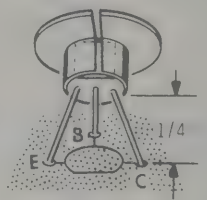
PICTORIAL 1-4

CONTINUE

NOTE: In the next four steps, install heat sinks on each transistor as shown. Place each heat sink on your work area as shown, and press the transistor into it. Be careful that you do not press the transistor in beyond the bottom edge of the heat sink.



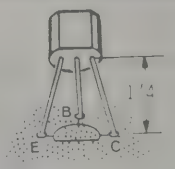
( ) Q101: MPSL51 transistor (#417-295) with heat sink.



( ) Q106: MPSA42 transistor (#417-294) with heat sink.

( ) Q107: MPSA42 transistor (#417-294) with heat sink.

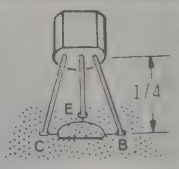
( ) Q113: MPSA42 transistor (#417-294) with heat sink.



Install two MPSA20 transistors (#417-801) as follows:

( ) Q103.

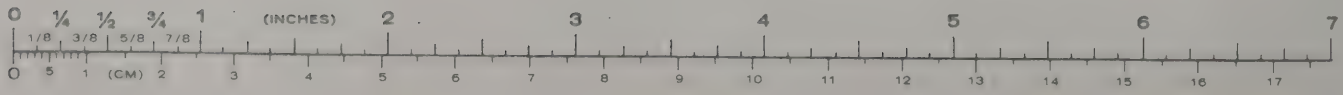
( ) Q112.

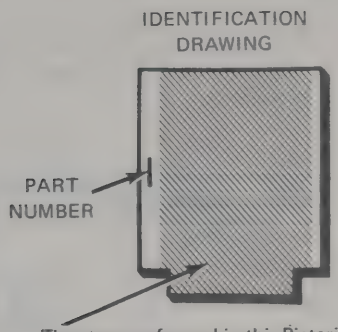


Install the matched transistor pair (#117-12) as follows:

( ) Q110.

( ) Q111.

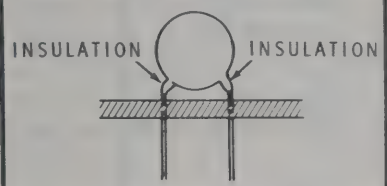




The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: When you install ceramic capacitors, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



( ) C116: .01 μF ceramic. . . . . .

( ) C152: 680 pF ceramic. . . . . .

( ) C151: 27 pF ceramic. . . . . .

( ) C121: .01 μF ceramic. . . . . .

( ) C112: .01 μF ceramic. . . . . .

( ) C128: 200 pF ceramic. . . . . .

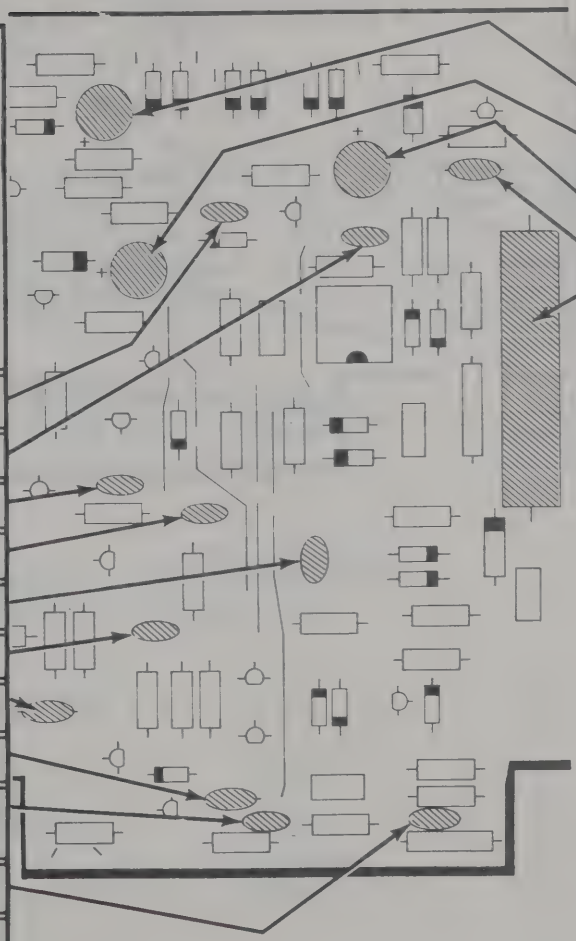
( ) C126: 2200 pF (.0022 μF) ceramic.

( ) C122: 2200 pF (.0022 μF) ceramic.

( ) C129: 24 pF ceramic. NOTE: Value not marked on circuit board.

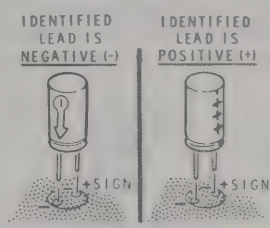
( ) C141: 100 pF ceramic. . . . . .

( ) Solder the leads to the foil and cut off the excess lead lengths.



CONTINUE

CAUTION: Before you install an electrolytic capacitor, note the polarity (+ or −) of the identified lead. Be sure you always connect the positive (+) lead to the positive (+) marked point on the circuit board.



( ) C101: 100 μF electrolytic.

( ) C111: 100 μF electrolytic.

( ) C115: 100 μF electrolytic.

( ) C117: 4700 pF (.0047 μF) ceramic.

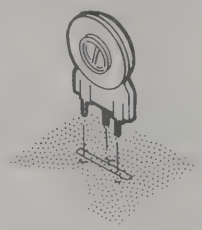
( ) R158: .1 Ω, .5%, 10-watt precision. NOTE: Be sure to form a good uniform solder connection around each lead of this resistor.

( ) Solder the leads to the foil and cut off the excess lead lengths.

PICTORIAL 1-5

START

NOTE: To install a control, insert the lugs into their holes and press the control against the circuit board. Solder the lugs to the foil as you install each control.



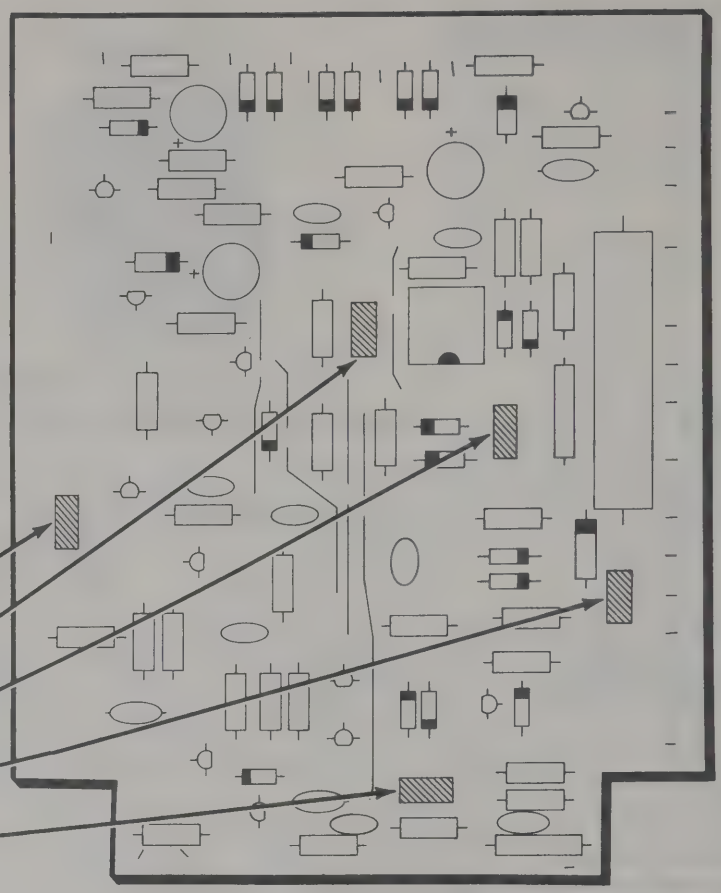
( ) R114: 5000 Ω (5k) control (#10-904).

( ) R152: 500 kΩ control (#10-946).

( ) R162: 20 kΩ control (#10-390).

( ) R116: 20 kΩ control (#10-390).

( ) R135: 200 Ω control (#10-917).



PICTORIAL 1-6

CONTINUE

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections. Disregard the unused holes.

( ) Poor solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitors for the correct position of the positive (+) side.

( ) Diodes for the correct position of the banded end.

FINISH

This completes the circuit board assembly. Please set it aside until it is called for later.

CHASSIS ASSEMBLY

PARTS LIST

Unpack the remaining parts and check each part against the following list. Make a check (✓) in the space provided as you identify each part. Any part that is packaged in an individual envelope with a part number on it should be placed back in the envelope after you identify it, until it is called for in a step.

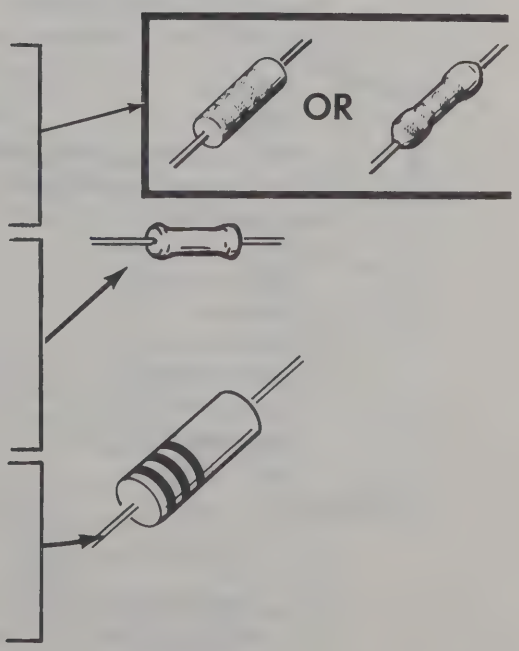
To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with the kit. If one is not available, see "Replacement Parts" inside the rear cover of this Manual. Your Warranty is located inside the front cover. For pricing information, refer to the separate "Heath Parts Price List."

QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.

RESISTORS

NOTE: 5% resistors have a gold fourth color band, 10% resistors have a silver fourth color band, and precision resistors are not color coded.

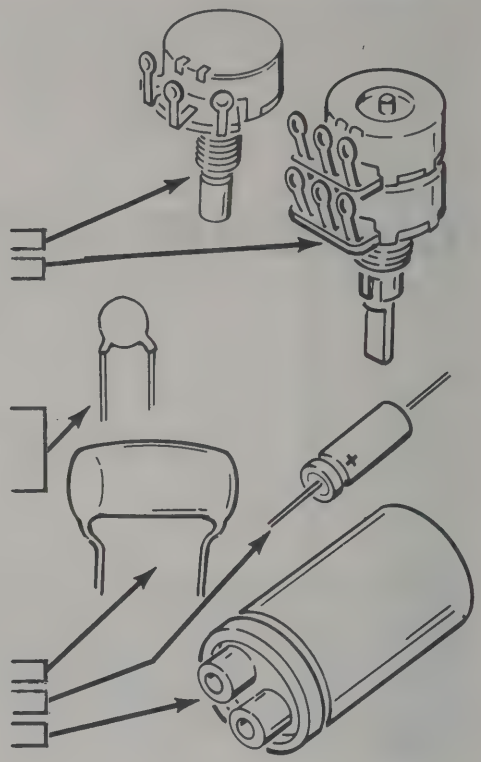
( )	1	15 Ω, 5%, 1/2-watt (brown-green-black)	1-54	R11
( )	2	47 Ω, 10%, 1/2-watt (yellow-violet-black)	1-1	R12, R14,
( )	1	150 Ω, 10%, 1/2-watt (brown-green-brown)	1-66	Used for calibration.
( )	1	5000 Ω (5K), 1%, 1/4-watt, 100 PPM/C precision	2-44-12	R26
( )	1	30 kΩ, 1%, 1/2-watt precision	2-201	R24
( )	1	55 kΩ, 1%, 1/4-watt, 25 PPM/C precision	2-699-12	R25
( )	2	0.33 Ω, 5%, 2-watt (orange-orange-silver)	3-2-2	R13, R15
( )	1	68 Ω, 10%, 2-watt (blue-gray-black)	1-40-2	R1
( )	2	2700 Ω, 10%, 2-watt (red-violet-red)	1-1-2	R2, R3



	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.
CONTROLS				
( )	1	2000 Ω (2k)	10-269	R23
( )	1	50 kΩ, 10 kΩ dual control	12-137	R21, R22
CAPACITORS				
( )	1	470 pF ceramic	21-56	C11
( )	1	5000 pF (.005 μF), 1400V (1.4 kV) ceramic	21-72	C1

NOTE: Mylar capacitors can be marked three different ways. EXAMPLE: .1, .1k, or .1 μF. However, the parts list and installation instructions will always use μF.

( )	1	0.1 μF Mylar	27-72	C23
( )	1	1.5 μF electrolytic	25-299	C21
( )	2	6000 μF electrolytic	25-809	C2, C23



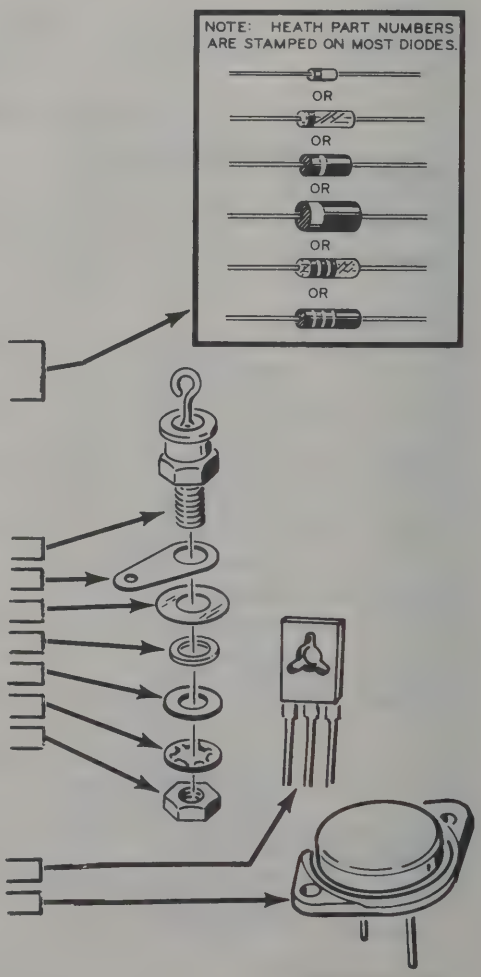
DIODES-TRANSISTORS

NOTE: Diodes and transistors are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits this refers only to the numbers; the letters may be different or missing.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

( )	2	3A1 diode	57-42	D1, D2
( )	1	1N4002 diode	57-65	D22
( )	2	MR1122 (diode assembly) Each diode assembly includes the following parts:	57-89	D11, D21

- 1 MR1122 diode
- 1 Solder lug
- 2 Mica insulator
- 1 Nylon bushing
- 1 Flat washer
- 1 Lockwasher
- 1 Nut

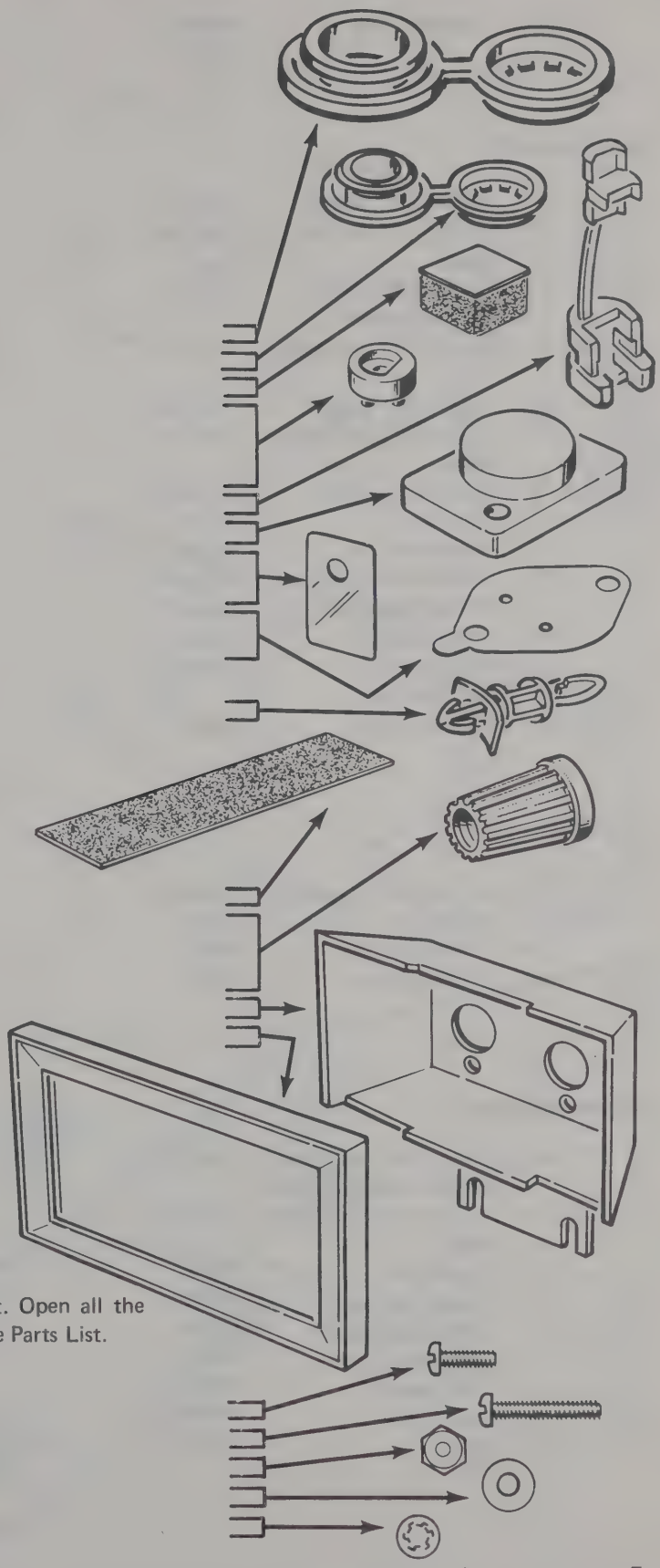


( )	1	SJE608 transistor	417-264	Q1
( )	2	2N6306 transistor	417-833	Q2, Q3,

QTY.		DESCRIPTION	HEATH Part No.

INSULATORS-PLASTIC PARTS

( )	3	3/4" plastic grommet	73-44
( )	3	1/2" plastic grommet	73-45
( )	4	1/2" x 1/2" foam pad	73-142
( )	2	Black binding post base	75-17
( )	2	Red binding post base	75-197
( )	2	Green binding post base	75-198
( )	1	Line cord strain relief	75-723
( )	2	Transistor cover	75-142
( )	1	Small transistor insulator	75-204
( )	2	Large transistor insulator	75-707
( )	4"	Sleeving	346-1
( )	4	Circuit board support	75-710
( )	2	Insulating paper	75-711
( )	1	Black binding post cap	100-16-2
( )	1	Red binding post cap	100-16-18
( )	1	Green binding post cap	100-699
( )	1	Meter light shield	206-1109
( )	1	Meter bezel	210-70



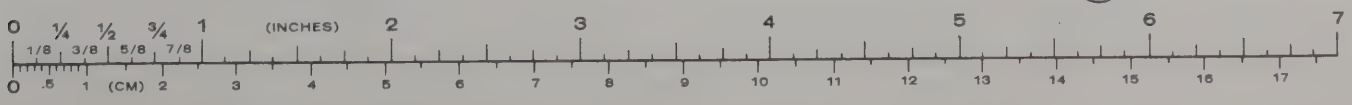
HARDWARE

(Shown to actual size.)

NOTE: The hardware may be in more than one packet. Open all the hardware packets before you check the hardware against the Parts List.

#4 Hardware

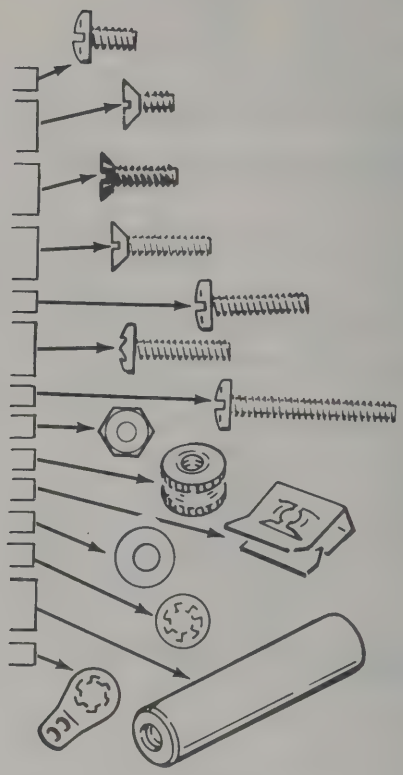
( )	2	4-40 x 5/16" screw	250-213
( )	1	4-40 x 5/8" screw	250-323
( )	3	4-40 nut	252-2
( )	1	#4 flat washer	253-82
( )	3	#4 lockwasher	254-9



	QTY.	DESCRIPTION	HEATH Part No.

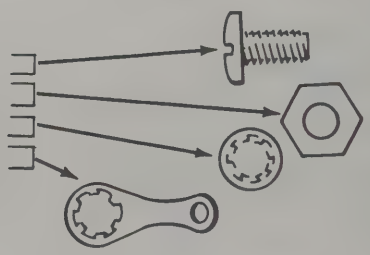
#6 Hardware

( )	11	6-32 x 1/4" screw	250-56
( )	2	6-32 x 1/4" flat head screw	250-416
( )	24	6-32 x 3/8" black flat head screw	250-276
( )	14	6-32 x 1/2" flat head screw	250-11
( )	13	6-32 x 1/2" screw	250-162
( )	2	6-32 x 1/2" phillips head screw	250-1150
( )	9	6-32 x 7/8" screw	250-1173
( )	45	6-32 nut	252-3
( )	1	6-32 thumb nut	252-23
( )	16	6-32 push-on nut	252-84
( )	2	#6 flat washer	253-127
( )	57	#6 lockwasher	254-1
( )	4	6-32 x 1-1/8" threaded spacer	255-60
( )	8	#6 solder lug	259-1



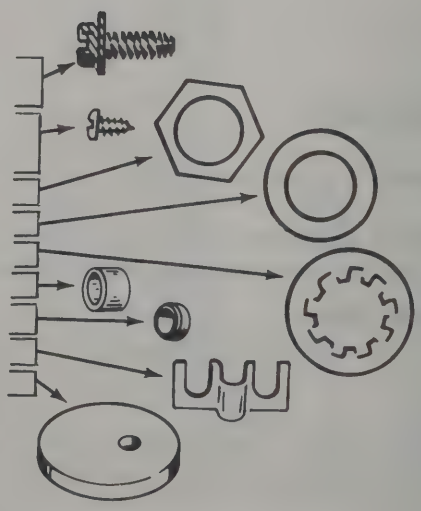
#10 Hardware

( )	12	10-32 x 5/16" screw	250-566
( )	8	10-32 nut	252-5
( )	8	#10 lockwasher	254-3
( )	12	#10 solder lug	259-5

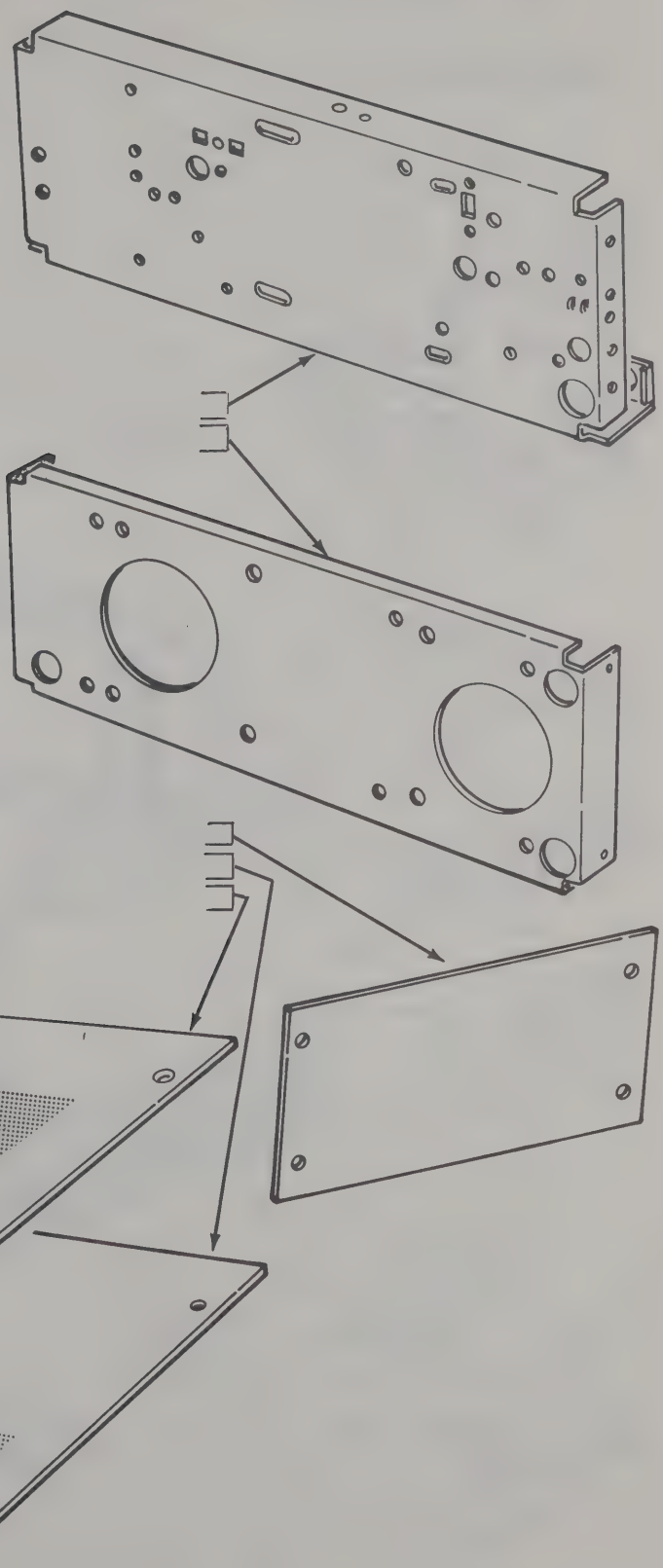


Other Hardware

( )	2	8-32 x 3/8" black hex-head self-tapping screw	250-1166
( )	4	#2 x 3/16" sheet metal screw	250-355
( )	2	Control nut	252-7
( )	2	Control flat washer	253-10
( )	2	Control lockwasher	254-4
( )	4	1/8" spacer	255-1
( )	2	1/16" spacer	255-74
( )	4	Jumper clip	260-88
( )	2	Cam nut	454-25



QTY.	DESCRIPTION	HEATH Part No.

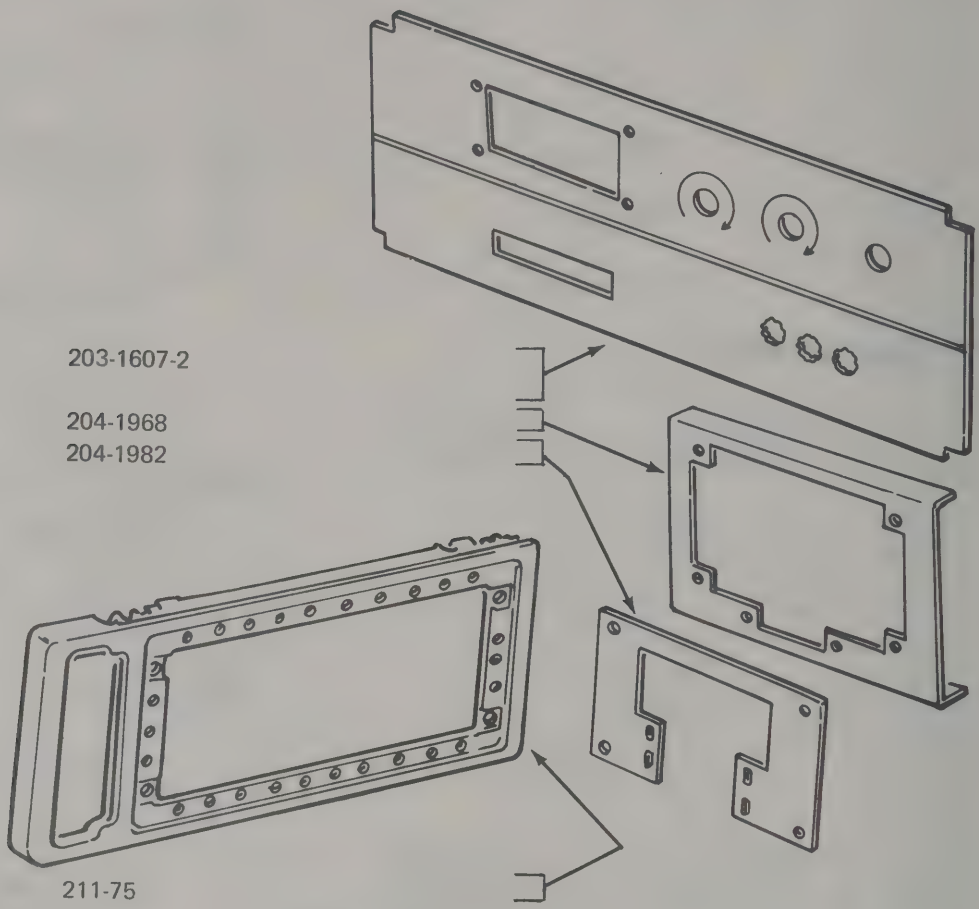


CHASSIS PARTS

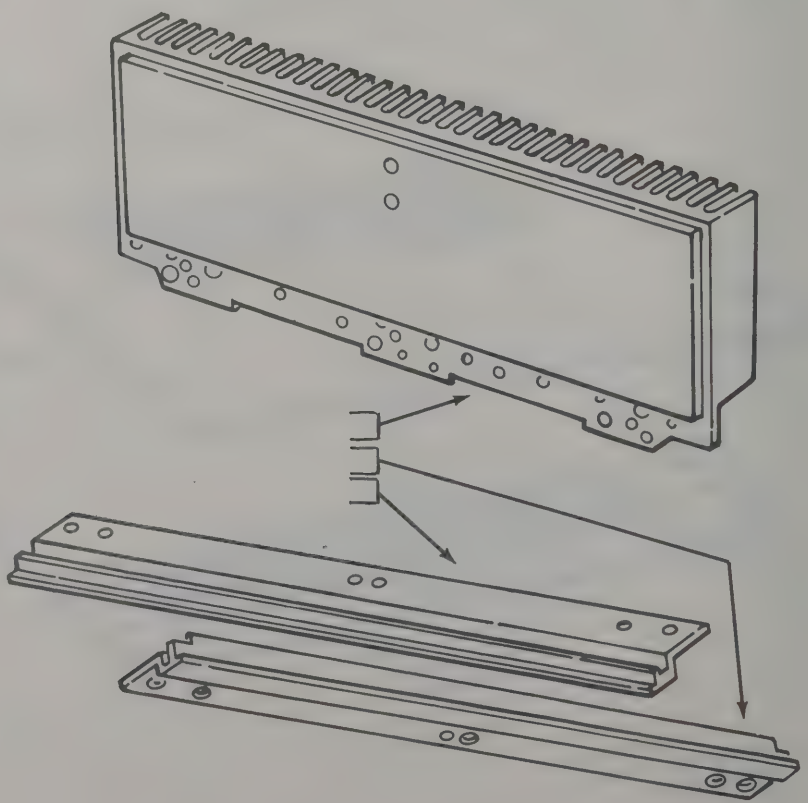
( )	1	Rear panel	200-1260
( )	1	Middle panel	200-689
( )	2	Side panel	203-1496-3
( )	1	Bottom panel	203-1606-3
( )	1	Top panel	203-1605-3

QTY.	DESCRIPTION	HEATH Part No.

Chassis Parts (cont'd.)



( )	1	Front panel (slight bowing is normal)	203-1607-2
( )	1	Switch bracket	204-1968
( )	1	Meter bracket	204-1982
( )	2	Handle	211-75



( )	1	Heat sink	215-82
( )	1	Top trim rail	216-71
( )	1	Bottom trim rail	216-72

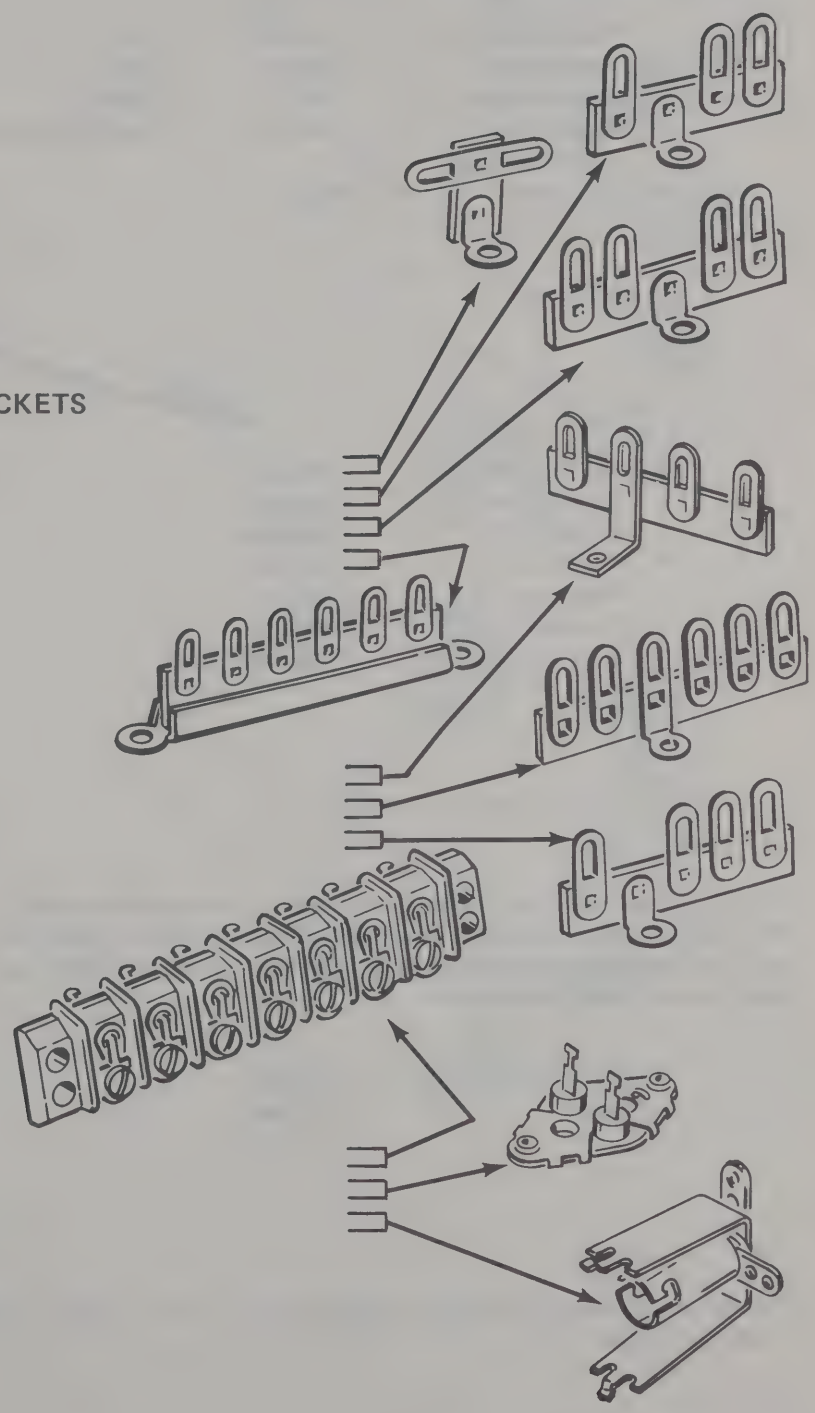
QTY.		DESCRIPTION	HEATH Part No.

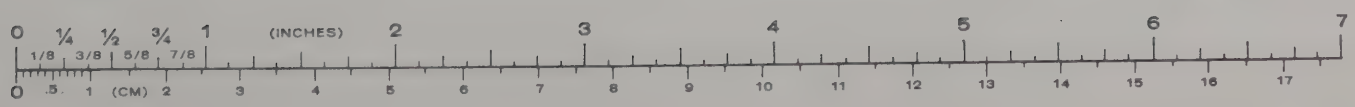
WIRE

( )	6"	Bare solid	340-3
( )	6"	Large black stranded	344-7
( )	24"	Small red stranded	344-16
( )	6"	Green stranded	344-32
( )	6"	Large white stranded	344-46
( )	24"	Black solid	344-50
( )	30"	Small white stranded	344-82
( )	13"	Large red stranded	344-118

TERMINAL STRIPS-BARRIER STRIPS-SOCKETS

( )	1	1-lug terminal strip	431-1
( )	2	3-lug terminal strip	431-3
( )	1	4-lug terminal strip	431-5
( )	1	6-lug terminal strip	431-20
( )	1	4-lug terminal strip	431-44
( )	1	6-lug terminal strip	431-55
( )	1	4-lug terminal strip	431-79
( )	2	7-lug barrier strip	431-97
( )	2	Transistor socket	434-117
( )	2	Lamp socket	434-220

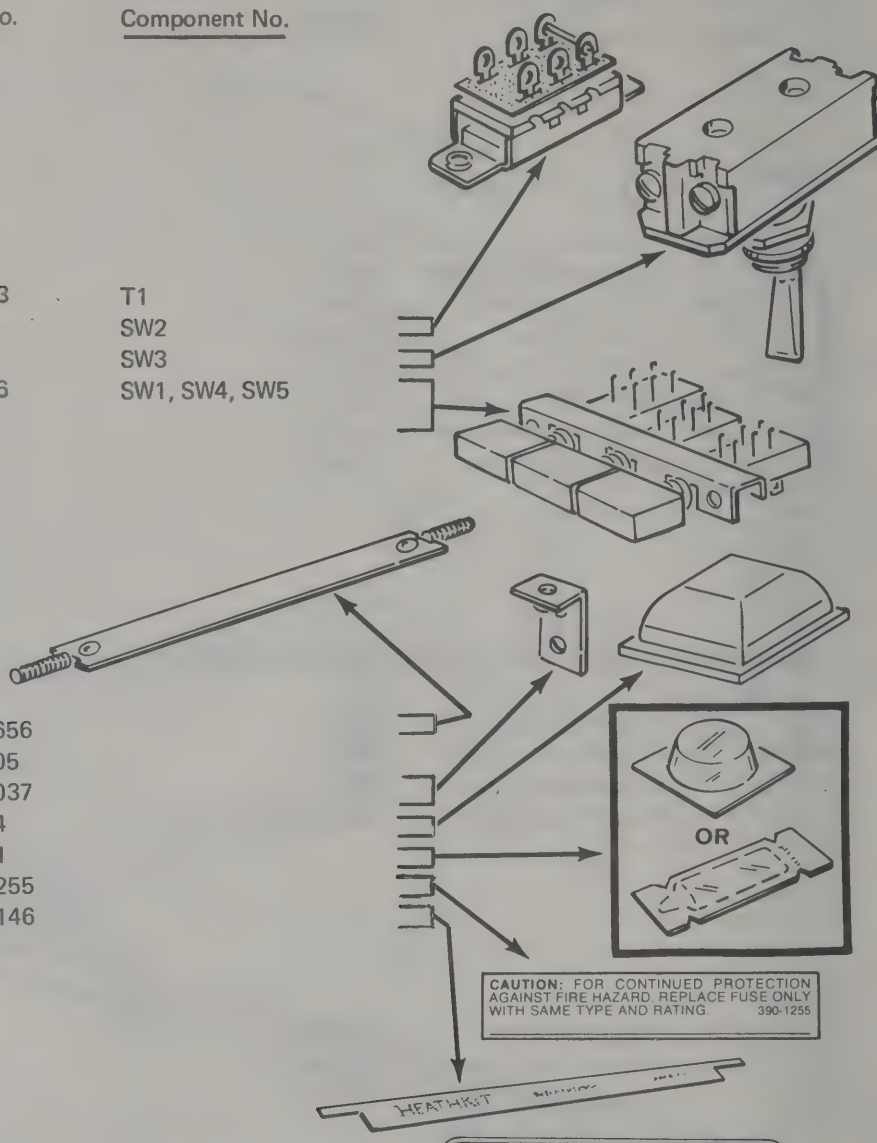




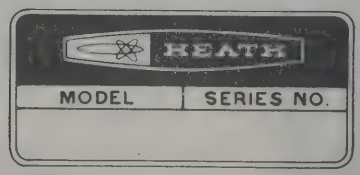
QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.

MISCELLANEOUS PARTS

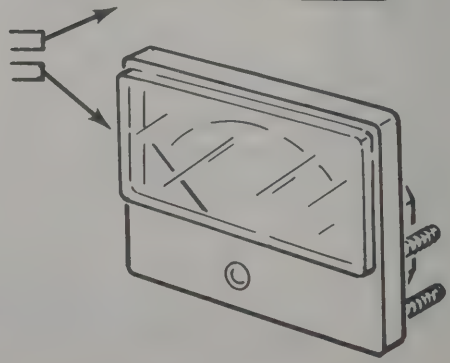
( )	1	Power transformer	54-863	T1
( )	1	Slide switch	60-54	SW2
( )	1	Toggle switch	61-22	SW3
( )	1	Pushbutton switch assembly	64-676	SW1, SW4, SW5
( )	1	Line cord	89-50	
( )	2	Capacitor clamp	100-1656	
( )	1	Wire harness	134-905	
( )	1	L-bracket	204-2037	
( )	4	Plastic foot	261-34	
( )	1	Thermal grease*	352-31	
( )	1	Fuse label	390-1255	
( )	1	Trim label	390-1146	



NOTE: Be sure you refer to the numbers on the Blue and White label in any communications you may have with the Heath Company about this kit. You may want to write the model and series numbers in this sample label for your future convenience.



( )	1	Blue and white label	391-34	
( )	1	Meter	407-190	M1

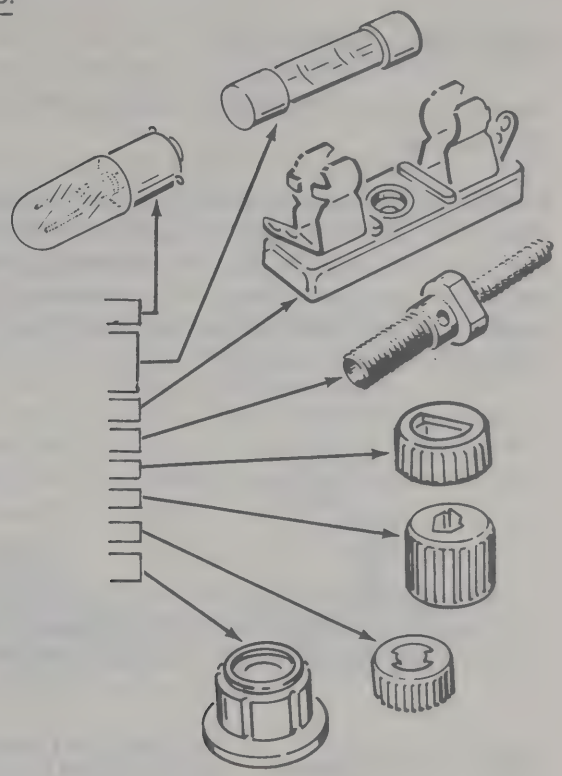


*Dow Corning thermal heat sink compound contains Zinc Oxides, SiO_2, and slight traces of CO_2.

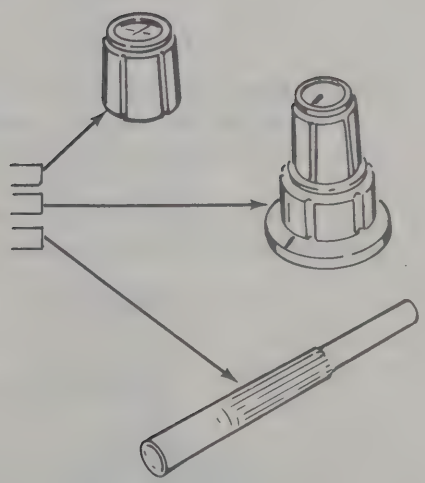
	QTY.	DESCRIPTION	HEATH Part No.	CIRCUIT Component No.

Miscellaneous (cont'd.)

( )	2	Lamp (#47)	412-1	PL1, PL2
( )	1	1-1/2-ampere fuse	421-1	F1
( )	1	3-ampere fuse	421-2	F1
( )	1	Fuseholder	422-1	
( )	3	Binding post base	427-3	
( )	1	1/4"-hole knob bushing	455-619	
( )	1	3/16"-hole knob bushing	455-51	
( )	1	Concentric knob bushing	455-52	
( )	1	Large black knob	462-361	



( )	1	Small red knob	462-363	
( )	1	Double knob	462-924	
( )	1	Nut starter	490-5	

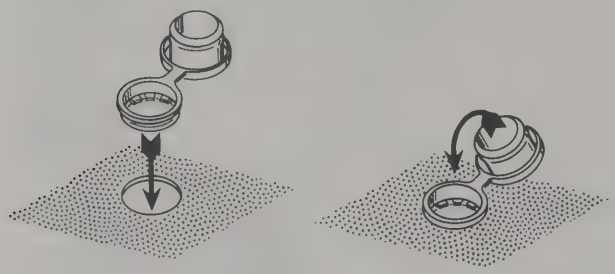


STEP-BY-STEP ASSEMBLY

REAR PANEL ASSEMBLY

Refer to Pictorial 2-1 (fold-out from Page 33) for the following steps.

Position the rear panel so that the front is toward you as shown in the lower portion of Pictorial 2-1. Each part that you mount is shown in place on the Pictorial, and the Details show an exploded view of the part being mounted. Always refer to the Detail for how to install the part and the Pictorial for where to install it.



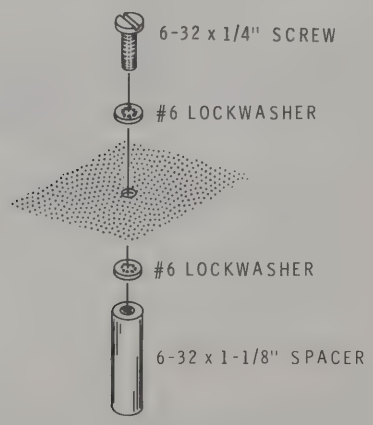
POSITION THE SMALL PORTION OF THE GROMMET INTO THE CHASSIS HOLE.

BEND THE LARGE PORTION OF THE GROMMET OVER AND INTO THE SMALL PORTION. PRESS IT FIRMLY INTO PLACE.

Detail 2-1A

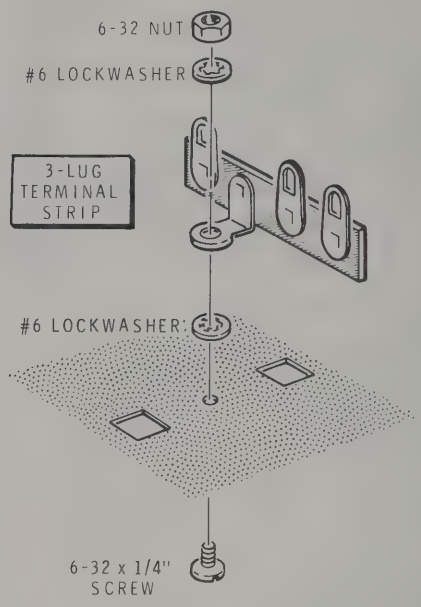
( ) Refer to Detail 2-1A and install 1/2" plastic grommets in holes AG, AT, and AX. They can be installed from either side of the panel.

( ) Install a 3/4" plastic grommet in hole AZ. It can be installed from either side of the panel.



Detail 2-1B

( ) Refer to Detail 2-1B and mount a 6-32 x 1-1/8" spacer to the back of the rear panel with a 6-32 x 1/4" screw and two #6 lockwashers at each of the following holes: AA, AF, AP, and AY.

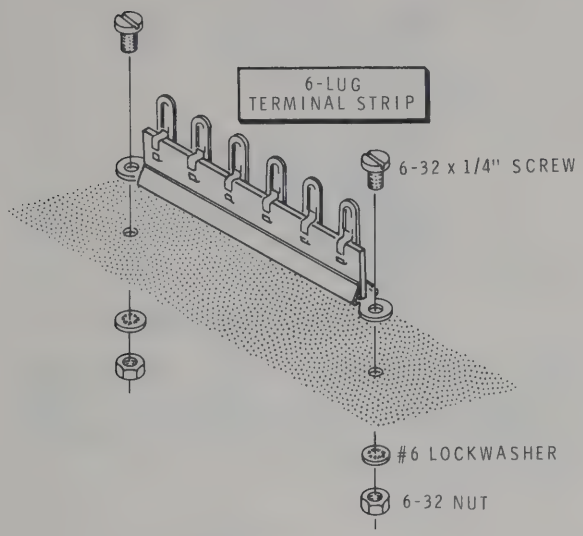


Detail 2-1C

NOTE: Use the plastic nut starter provided with this kit to hold and start 6-32 and 4-40 nuts on screws.

( ) Refer to Detail 2-1C and mount the 3-lug terminal strip (#431-3) on the front of the rear panel at AH with a 6-32 x 1/4" screw, two #6 lockwashers, and a 6-32 nut.

( ) Refer to Detail 2-1D and mount a 6-lug terminal strip (#431-20) on the front of the rear panel at AJ. Use two 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts.



Detail 2-1D

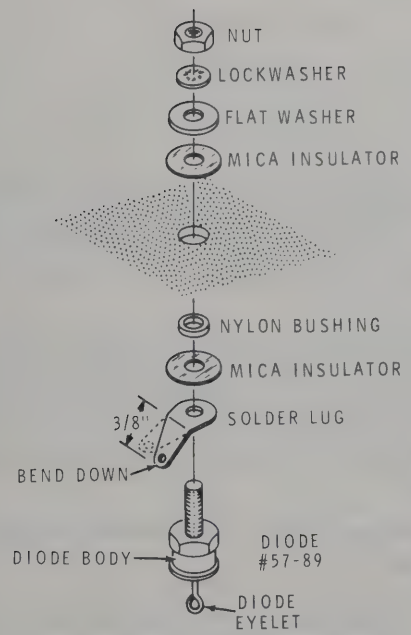
( ) Refer to Detail 2-1E and:

1. Locate and remove an MR1122 diode (#57-89) and hardware from its packaging. Be careful not to lose the small nylon bushing or mica insulators.

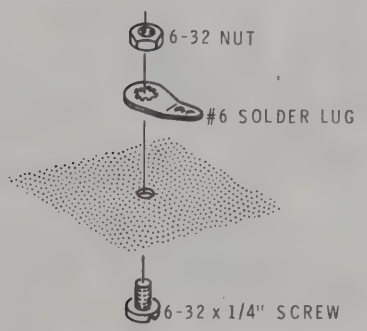
2. Hold the large part of the solder lug with a pair of pliers and bend the small end of the solder lug down approximately 60°. The bent portion of the solder lug should be approximately 3/8" long.

3. D11: Mount the diode to the back of the rear panel in hole D11. Use the hardware supplied with the diode. Be sure to position the nylon bushing inside the mounting hole so the diode will be insulated from the panel. NOTE: Secure the diode so the diode eyelet and solder lug are positioned as shown in Pictorial 2-1 (fold-out from Page 33).

( ) D21: In the same manner, locate and mount an MR1122 diode (#57-89) in hole D21. Secure the diode so the diode eyelet and solder lug are positioned as shown in Pictorial 2-1.



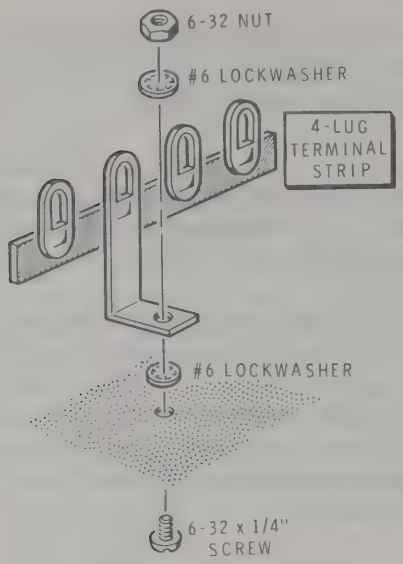
Detail 2-1E



Detail 2-1F

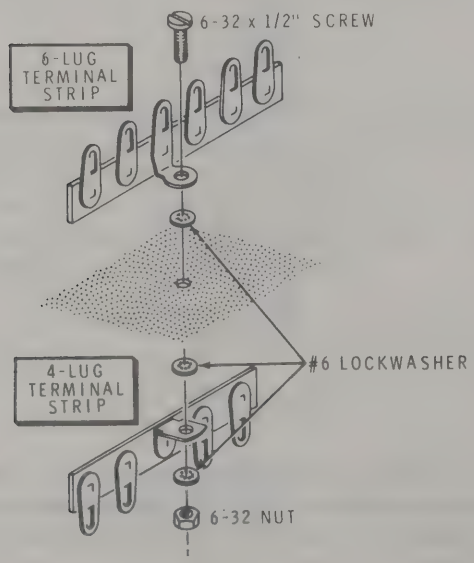
( ) If you have an ohmmeter, measure the resistance between the diode body (solder lug) and the rear panel at both D11 and D21. There should be infinite resistance.

( ) Refer to Detail 2-1F and mount a #6 solder lug to the front of the rear panel at hole AW with a 6-32 x 1/4" screw and 6-32 nut.



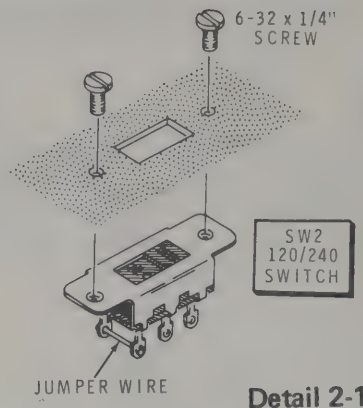
Detail 2-1G

( ) Refer to Detail 2-1G and mount a 4-lug terminal strip (#431-44) to the front of the rear panel at hole AV with a 6-32 x 1/4" screw, two #6 lockwashers, and a 6-32 nut.



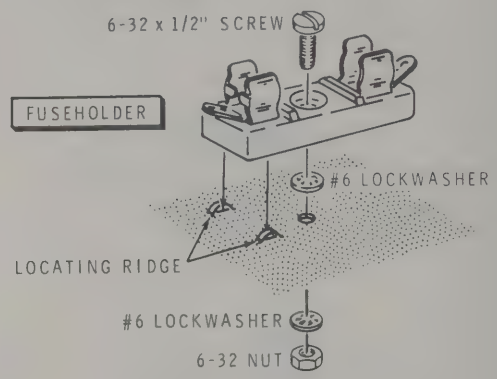
Detail 2-1H

( ) Refer to Detail 2-1H and mount a 6-lug terminal strip (#431-55) to the front of the rear panel and a 4-lug terminal strip (#431-5) to the back of the rear panel at hole AU. Use a 6-32 x 1/2" screw, three #6 lockwashers, and a 6-32 nut. Position the two terminal strips as shown.



Detail 2-1J

( ) SW2: Refer to Detail 2-1J and mount the slide switch, to the back of the rear panel at SW2 with two 6-32 x 1/4" screws. Position the switch so the jumper wire across the lugs is near hole AT.



Detail 2-1K

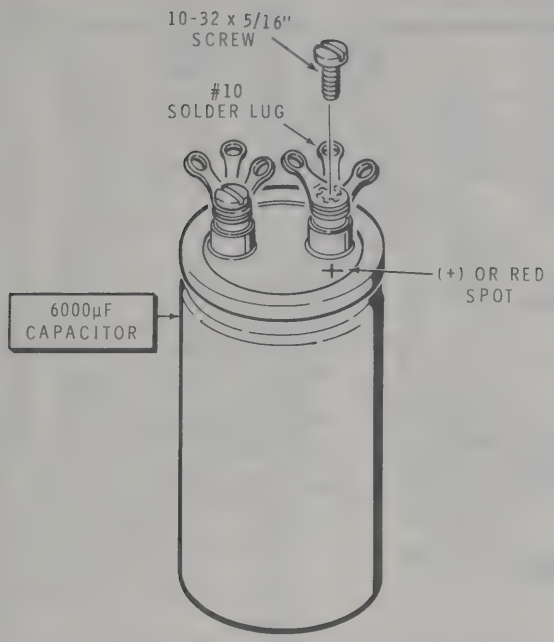
( ) Refer to Detail 2-1K and mount the fuseholder to the front of the rear panel at hole F1 with a 6-32 x 1/2" screw, two #6 lockwashers, and 6-32 nut. Position the fuseholder so it fits between the two locating ridges formed in the panel.

( ) Remove the backing paper from one of the insulating papers and center the insulating paper directly behind the panel cutout at AR. Position the insulating paper edge up against the cutout and press the paper against the panel.

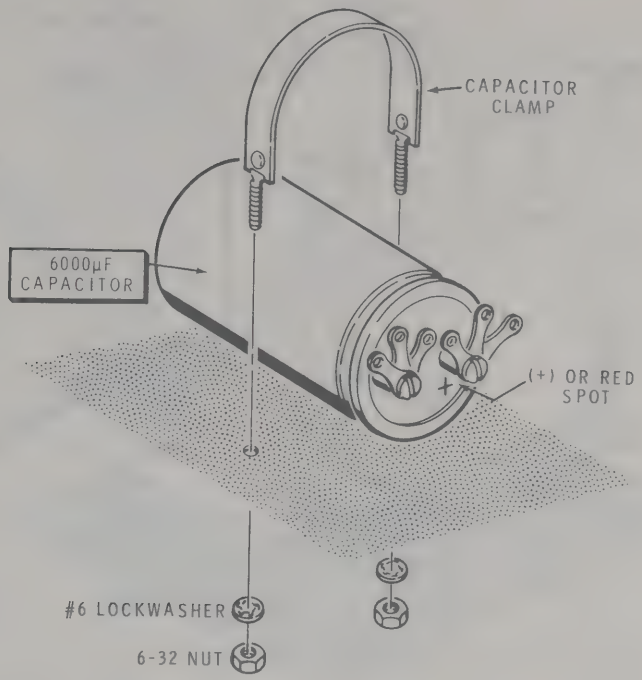
( ) In like manner, install a second insulating paper at cutout AS.

( ) Locate the fuse label. Then write the fuse type and rating on the label: 3AG, 3-ampere for 120 VAC operation. 3AG, 1-1/2-ampere for 240 VAC operation.

( ) Remove the backing paper from the fuse label and press the label onto the front of the rear panel next to the fuseholder as shown.



Detail 2-1L



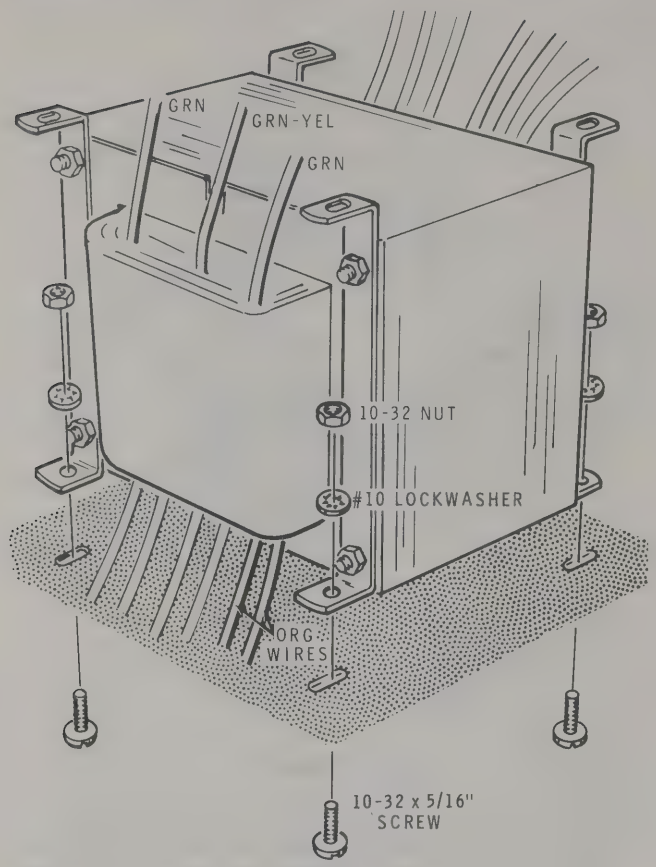
Detail 2-1M

( ) Refer to Detail 2-1L and install three #10 solder lugs on each post of a 6000 μF electrolytic capacitor with a 10-32 x 5/16" screw. Be sure the solder lugs face away from you when the positive (+) post is on the right. NOTE: Maintain at least 1/8" spacing between the positive and negative post solder lugs.

( ) In like manner, install three #10 solder lugs on each post of the other 6000 μF electrolytic capacitor.

( ) C2: Refer to Detail 2-1M and wrap a capacitor clamp around the middle of a 6000 μF capacitor, fit the capacitor clamp into holes AB and AC from the front of the rear panel, and secure the clamp with #6 lockwashers and 6-32 nuts at holes AB and AC. DO NOT overtighten the clamp! The capacitor can be damaged. Be sure to position the capacitor solder lugs as shown in Pictorial 2-1.

( ) C3: Wrap a capacitor clamp around the middle of the other 6000 μF electrolytic capacitor, fit the clamp into holes AD and AE from the front of the rear panel, and secure both ends of the clamp with #6 lockwashers and 6-32 nuts. DO NOT overtighten the clamp.



Detail 2-1N

( ) T1: Refer to Detail 2-1N and mount the power transformer to the front of the rear panel at holes AL, AM, AN, and AO with 10-32 x 5/16" screws, #10 lockwashers, and 10-32 nuts. Exact location in the holes is unimportant at this time. Note that the green-yellow and two green wires are positioned away from the rear panel on the side with holes AL and AM. Do not pinch any wires between the transformer and panel.

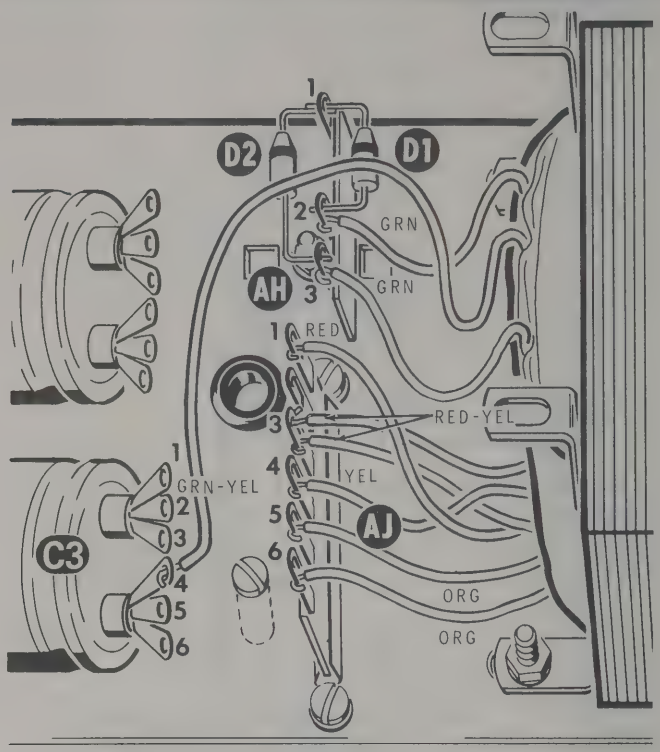
Refer to Pictorial 2-2 for the following steps.

NOTE: After a wire or component lead is connected in a step, an abbreviated solder instruction will also be given. (NS) means not to solder, because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following the "S-" tells how many wires are at the connection.

Connect the transformer leads to terminal strip AJ as follows. Do not shorten any of the transformer leads. NOTE: These wires will not be connected to any other part of the circuit.

( ) Either orange lead to lug 6 (S-1).

( ) Other orange lead to lug 5 (S-1).



PICTORIAL 2-2

( ) Yellow lead to lug 4 (S-1).

( ) Both red-yellow leads to lug 3 (S-2).

( ) Red lead to lug 1 (S-1). (Lug 2 is not used.)

( ) D1: Form the leads of a 3A1 diode (#57-42) as shown and connect the banded end of the diode to terminal strip AH lug 1 (NS). Connect the other lead of this diode to terminal strip AH lug 2 (NS).

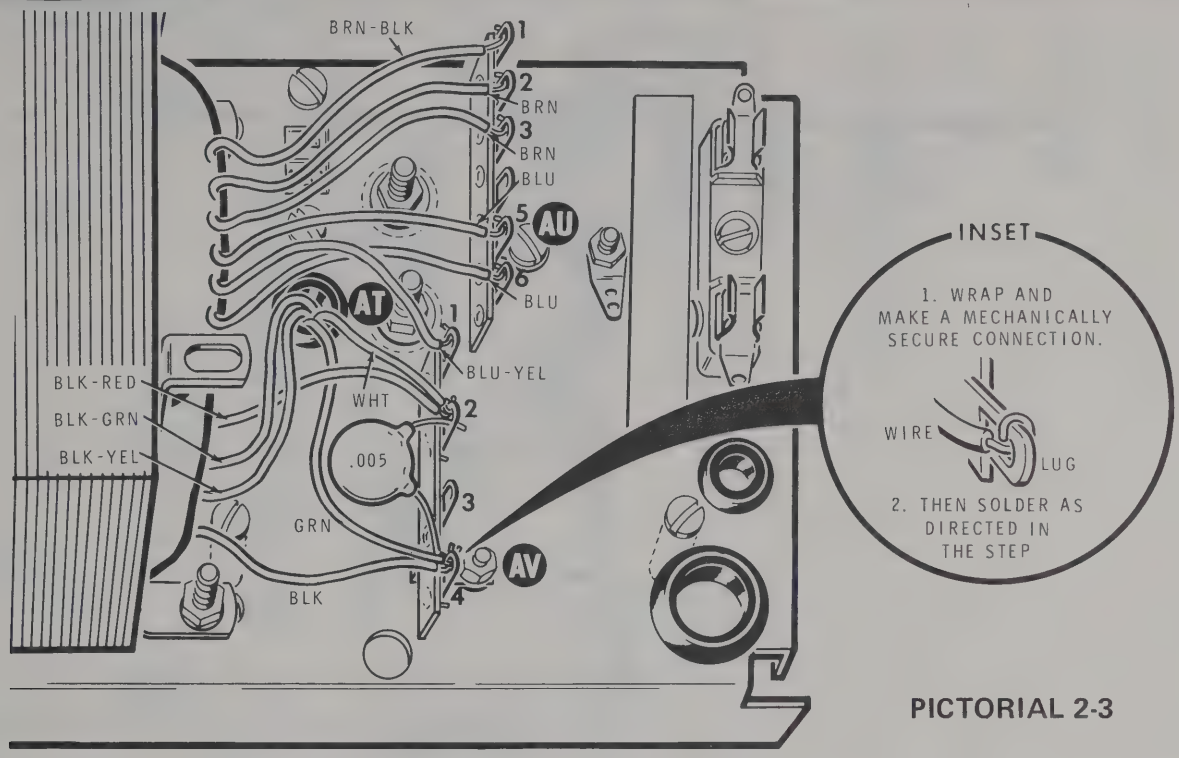
( ) D2: Form the leads of a 3A1 diode (#57-42) as shown and connect the banded end of the diode to terminal strip AH lug 1 (NS). Connect the other lead of this diode to terminal strip AH lug 3 (NS). NOTE: Be sure the diode lead does not touch the terminal strip mounting screw.

Connect the following transformer leads to terminal strip AH as follows:

( ) Either green lead to lug 3 (S-2).

( ) Other green lead to lug 2 (S-2).

( ) Connect the green-yellow transformer lead to capacitor C3 solder lug 4 (S-1).



PICTORIAL 2-3

Refer to Pictorial 2-3 for the following steps.

( ) Pass the black-green and black-yellow transformer leads through grommet AT. They will be connected later.

NOTE: You will be instructed to prepare lengths of wire ahead of time, as in the following steps. To prepare a wire, unless the step directs otherwise, cut it to the indicated length and remove 1/4" of insulation from each end. The wires are listed in the order in which they will be used. When stranded wire is called for, melt a small amount of solder on the bare wire ends to hold the small wire strands together.

( ) Prepare the following stranded wires:

6" Green
5" Large white

NOTE: Make a mechanically secure connection (as shown in the inset drawing) with each wire you connect to terminal strip AV before you solder the wire.

( ) Connect one end of the green wire to terminal strip AV lug 4 (NS). Pass the other end of the wire through grommet AT. It will be connected later.

( ) Connect one end of the large white wire to terminal strip AV lug 2 (NS). Pass the other end of the wire through grommet AT. It will be connected later.

( ) C1: Connect a .005 μF (5000 pF) (1.4 kV) ceramic capacitor to terminal strip AV between lugs 2 (NS) and 4 (NS).

( ) Connect the black transformer lead to terminal strip AV lug 4 (NS).

( ) Connect the black-red transformer lead to terminal strip AV lug 2 (NS).

( ) Connect the blue-yellow transformer lead to terminal strip AV lug 1 (NS).

Connect the remaining transformer leads to terminal strip AU as follows:

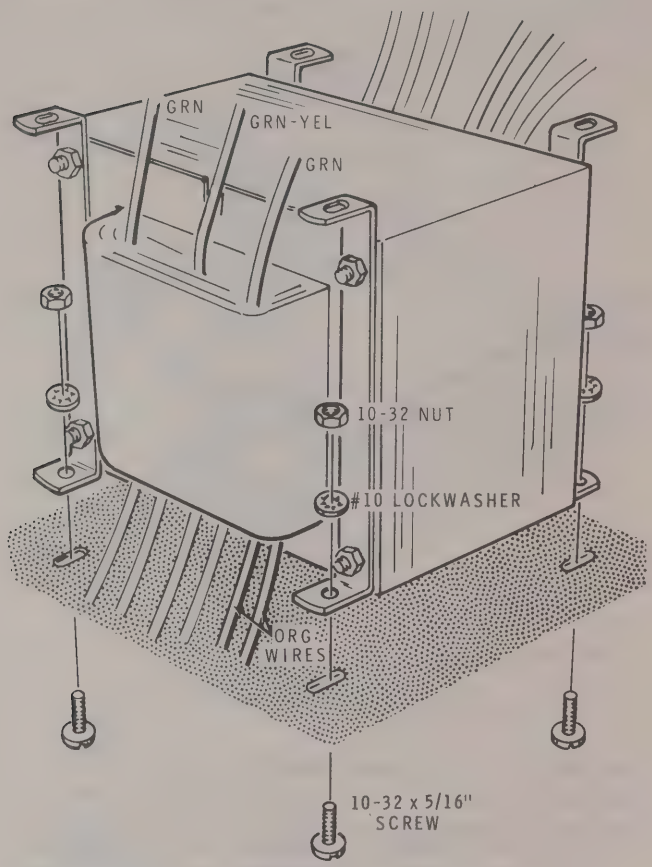
( ) Either blue lead to lug 6 (NS).

( ) Other blue lead to lug 5 (NS).

( ) Either brown lead to lug 3 (NS). NOTE: Lug 4 is not used at this time.

( ) Other brown lead to lug 2 (NS).

( ) Brown-black lead to lug 1 (NS).



Detail 2-1N

( ) T1: Refer to Detail 2-1N and mount the power transformer to the front of the rear panel at holes AL, AM, AN, and AO with 10-32 x 5/16" screws, #10 lockwashers, and 10-32 nuts. Exact location in the holes is unimportant at this time. Note that the green-yellow and two green wires are positioned away from the rear panel on the side with holes AL and AM. Do not pinch any wires between the transformer and panel.

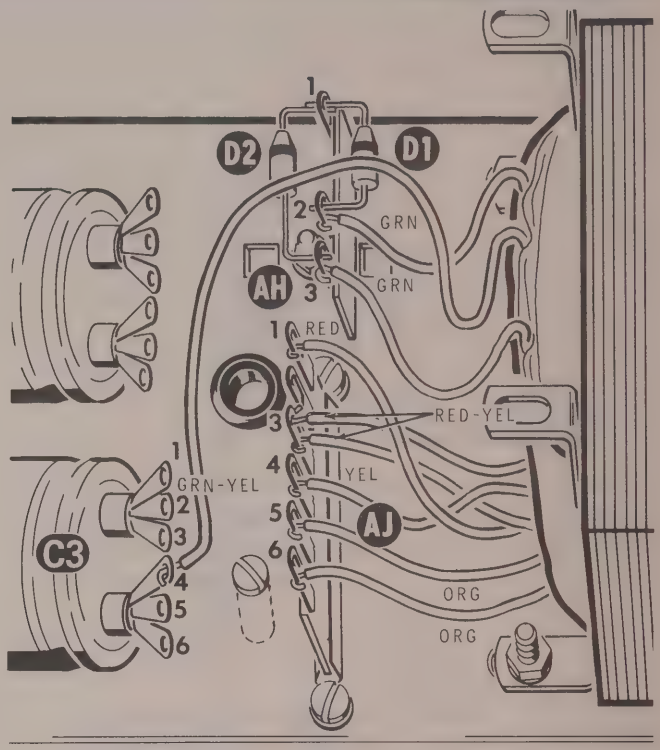
Refer to Pictorial 2-2 for the following steps.

NOTE: After a wire or component lead is connected in a step, an abbreviated solder instruction will also be given. (NS) means not to solder, because other wires will be added later. "S-" with a number, such as (S-3), means to solder the connection. The number following the "S-" tells how many wires are at the connection.

Connect the transformer leads to terminal strip AJ as follows. Do not shorten any of the transformer leads. NOTE: These wires will not be connected to any other part of the circuit.

( ) Either orange lead to lug 6 (S-1).

( ) Other orange lead to lug 5 (S-1).



PICTORIAL 2-2

( ) Yellow lead to lug 4 (S-1).

( ) Both red-yellow leads to lug 3 (S-2).

( ) Red lead to lug 1 (S-1). (Lug 2 is not used.)

( ) D1: Form the leads of a 3A1 diode (#57-42) as shown and connect the banded end of the diode to terminal strip AH lug 1 (NS). Connect the other lead of this diode to terminal strip AH lug 2 (NS).

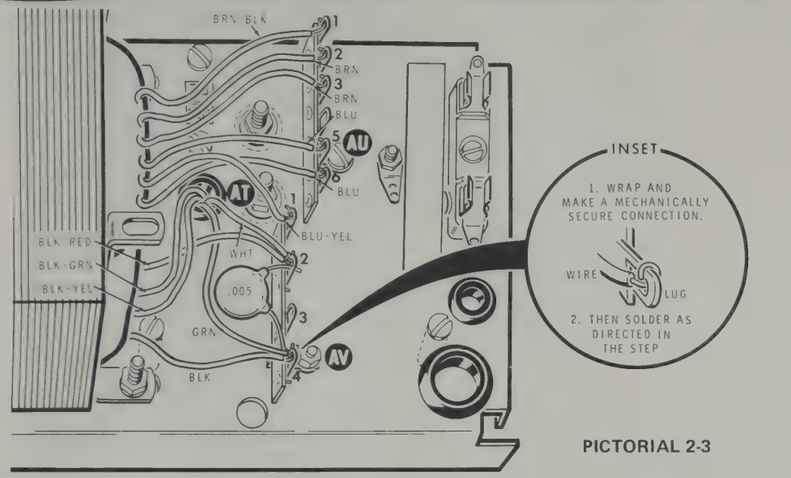
( ) D2: Form the leads of a 3A1 diode (#57-42) as shown and connect the banded end of the diode to terminal strip AH lug 1 (NS). Connect the other lead of this diode to terminal strip AH lug 3 (NS). NOTE: Be sure the diode lead does not touch the terminal strip mounting screw.

Connect the following transformer leads to terminal strip AH as follows:

( ) Either green lead to lug 3 (S-2).

( ) Other green lead to lug 2 (S-2).

( ) Connect the green-yellow transformer lead to capacitor C3 solder lug 4 (S-1).



PICTORIAL 2-3

Refer to Pictorial 2-3 for the following steps.

( ) Pass the black-green and black-yellow transformer leads through grommet AT. They will be connected later.

NOTE: You will be instructed to prepare lengths of wire ahead of time, as in the following steps. To prepare a wire, unless the step directs otherwise, cut it to the indicated length and remove 1/4" of insulation from each end. The wires are listed in the order in which they will be used. When stranded wire is called for, melt a small amount of solder on the bare wire ends to hold the small wire strands together.

( ) Prepare the following stranded wires:

6" Green
5" Large white

NOTE: Make a mechanically secure connection (as shown in the inset drawing) with each wire you connect to terminal strip AV before you solder the wire.

( ) Connect one end of the green wire to terminal strip AV lug 4 (NS). Pass the other end of the wire through grommet AT. It will be connected later.

( ) Connect one end of the large white wire to terminal strip AV lug 2 (NS). Pass the other end of the wire through grommet AT. It will be connected later.

( ) C1: Connect a .005 μF (5000 pF) (1.4 kV) ceramic capacitor to terminal strip AV between lugs 2 (NS) and 4 (NS).

( ) Connect the black transformer lead to terminal strip AV lug 4 (NS).

( ) Connect the black-red transformer lead to terminal strip AV lug 2 (NS).

( ) Connect the blue-yellow transformer lead to terminal strip AV lug 1 (NS).

Connect the remaining transformer leads to terminal strip AU as follows:

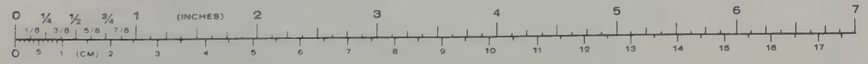
( ) Either blue lead to lug 6 (NS).

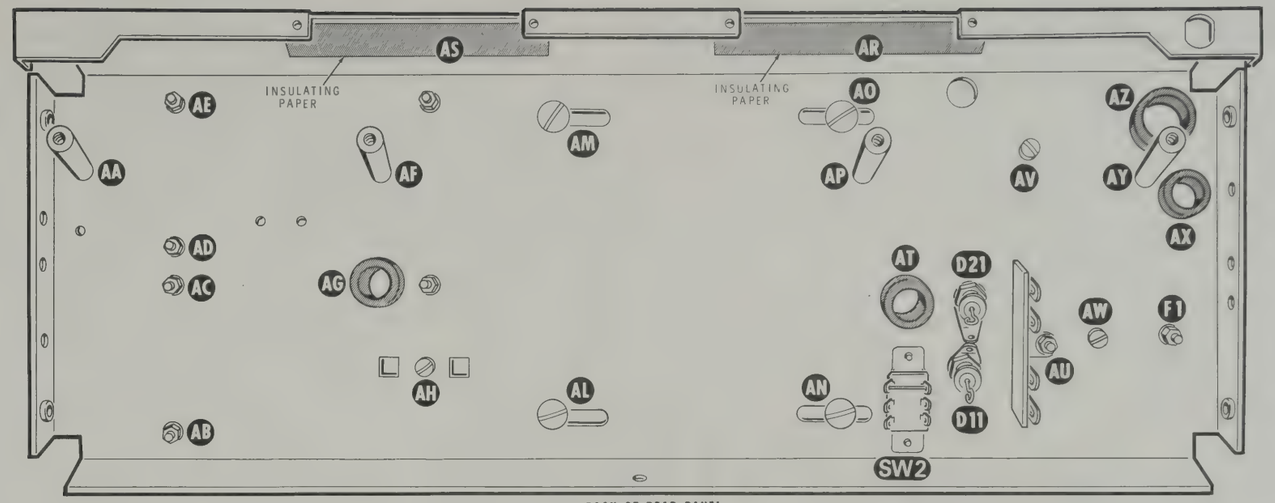
( ) Other blue lead to lug 5 (NS).

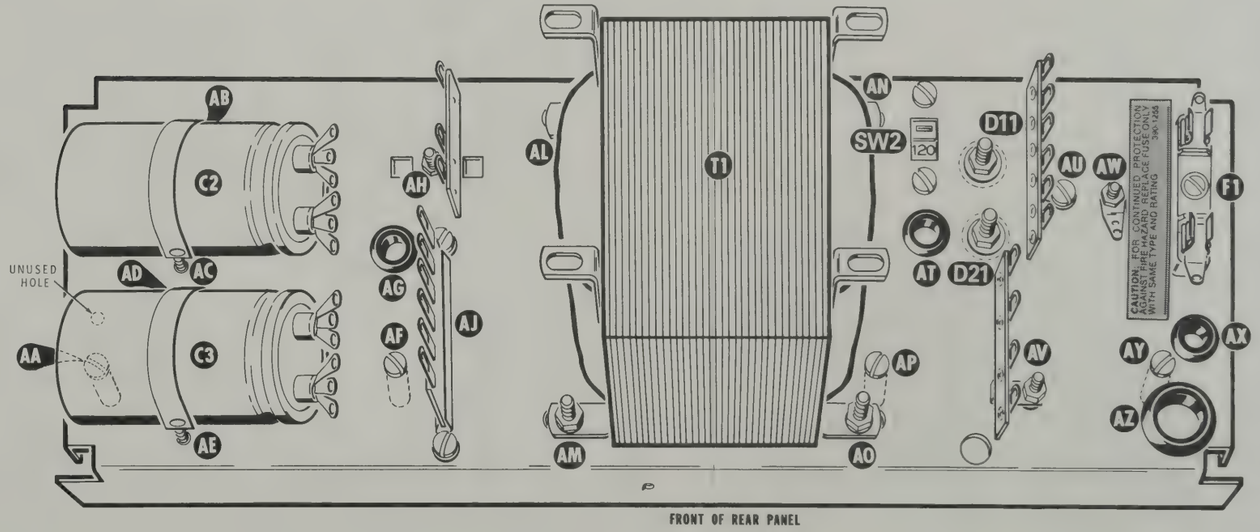
( ) Either brown lead to lug 3 (NS). NOTE: Lug 4 is not used at this time.

( ) Other brown lead to lug 2 (NS).

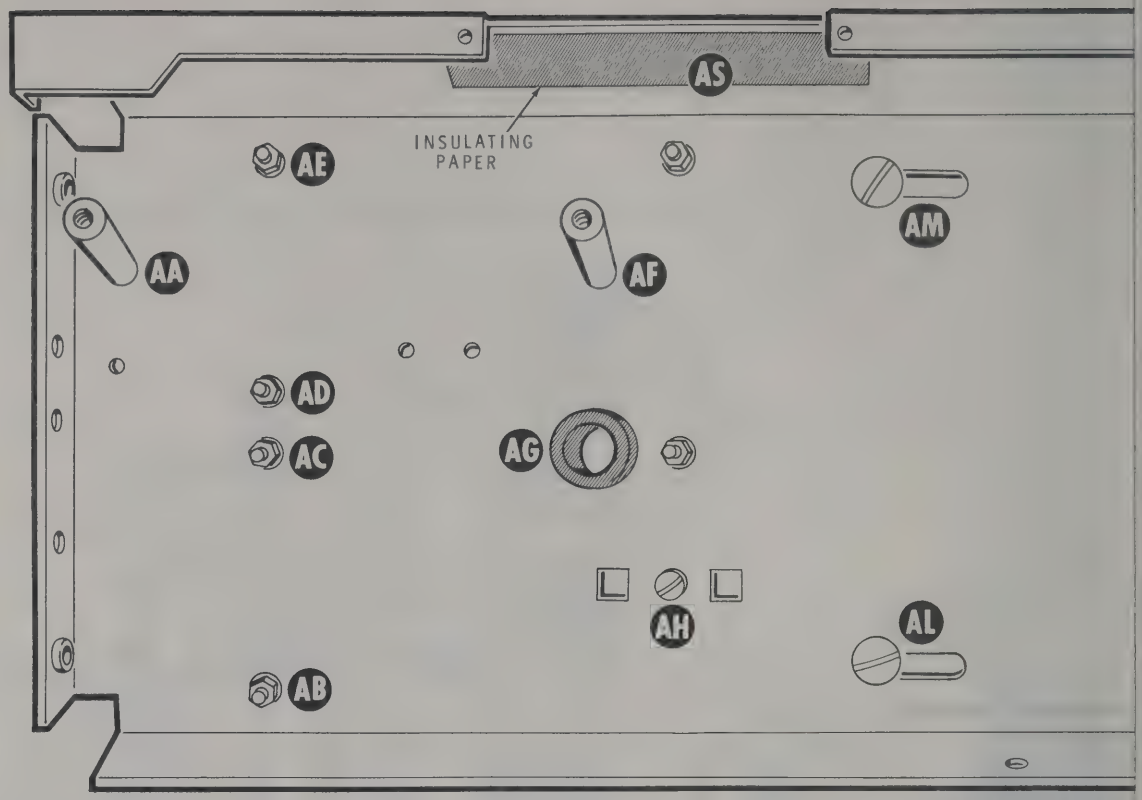
( ) Brown-black lead to lug 1 (NS).



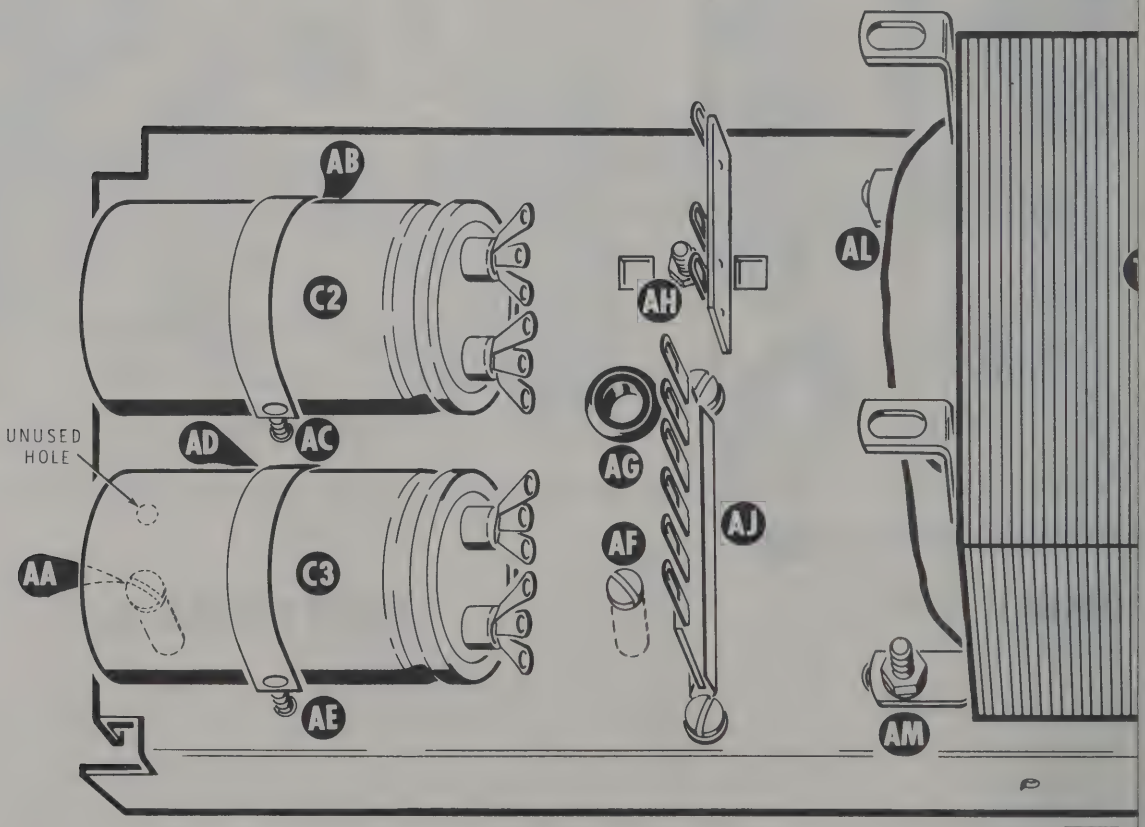




PICTORIAL 2-1

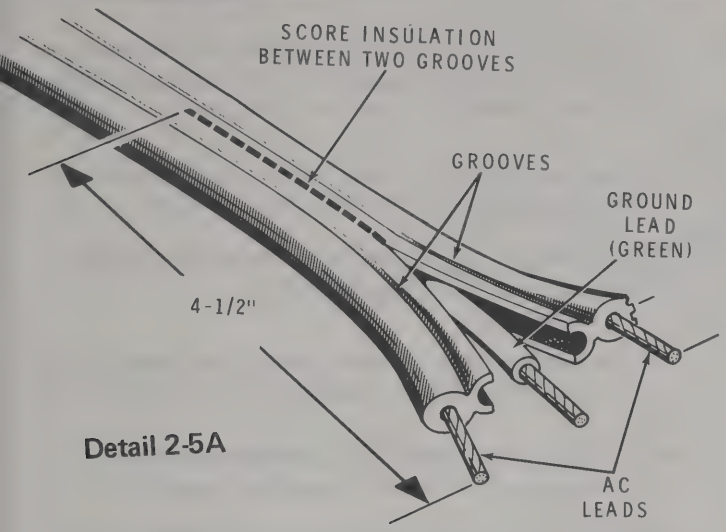


BACK OF REAR PANE



FRONT

PICTORIAL



Detail 2-5A

Refer to Pictorial 2-5 for the following steps.

NOTE: This instrument can be operated from a 120 VAC or a 240 VAC power source.

( ) Use a screwdriver to set switch SW2 to the position that will match your line voltage. For 120 VAC operation, set it so "120" is visible. For 240 VAC operation, set it so "240" is visible.

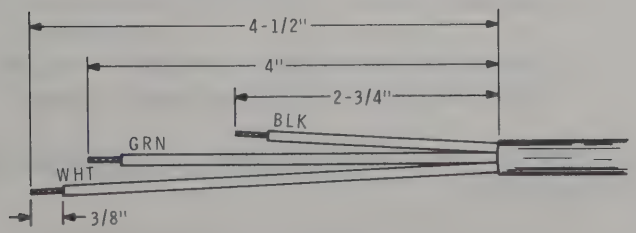
CAUTION: Electrical regulations in some areas require a special line cord and/or plug for 240-volt operation. If this cord and plug are not approved for your area, obtain an approved cord and plug locally and proceed with the following steps, making changes as necessary.

( ) Refer to Detail 2-5A and split the outer insulation of the line cord as shown so you do not cut into the protective insulation for the AC leads.

1. Use a knife point to score a line as shown, BETWEEN the two grooves.

2. Turn the cord over and repeat step 1.

3. Grasp the lead ends by the insulation and pull the leads apart. The line cord will separate on the scored lines.



Detail 2-5B

( ) Refer to Detail 2-5B and prepare the line cord wires. NOTE: Be sure to melt a small amount of solder on the wire ends after they are prepared.

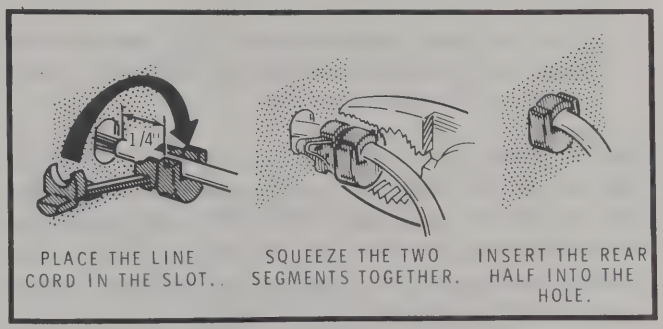
( ) Pass the prepared line cord wires through hole A1 and grommet AX.

NOTE: In the next three steps, make a mechanically secure connection with each line cord wire before you solder it.

( ) Connect the white wire to terminal strip AV lug 2 (S-4).

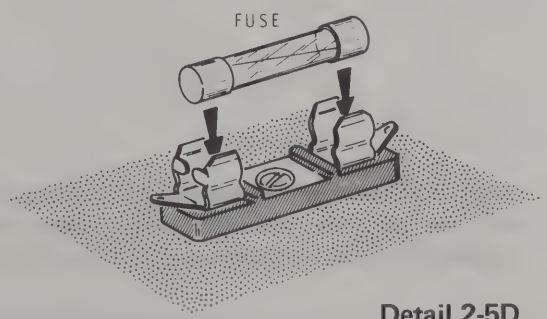
( ) Connect the green wire to solder lug AW (S-1).

( ) Connect the black wire to fuseholder F1 lug 2 (S-1).



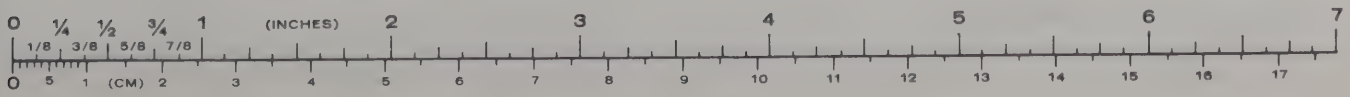
Detail 2-5C

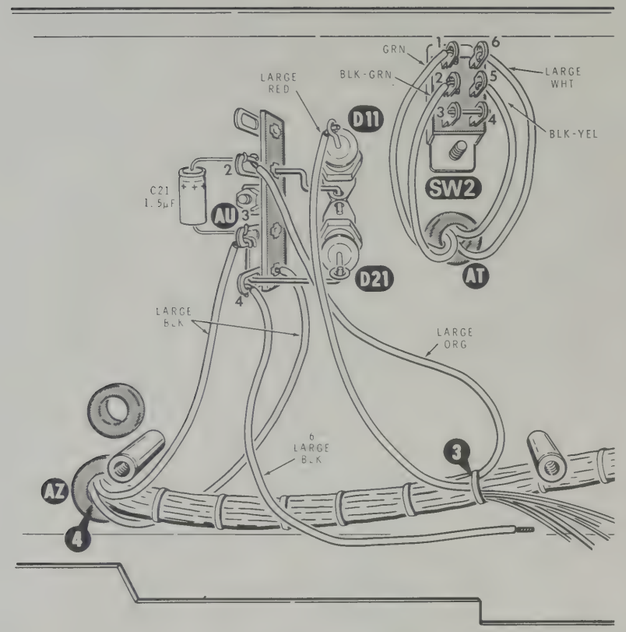
( ) Secure the line cord to the rear panel with the line cord strain relief as shown in Detail 2-5C. NOTE: Because of the thickness of the line cord, it will be necessary to apply a great amount of pressure when you squeeze the strain relief segments together. Use a large pair of pliers.



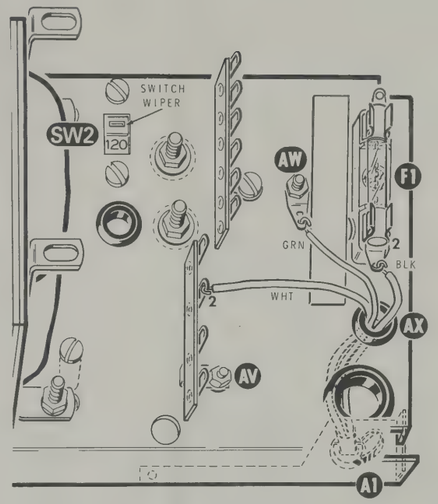
Detail 2-5D

( ) Refer to Detail 2-5D and install the required fuse: 3-ampere for 120-volt operation or 1-1/2-ampere for 240-volt operation.

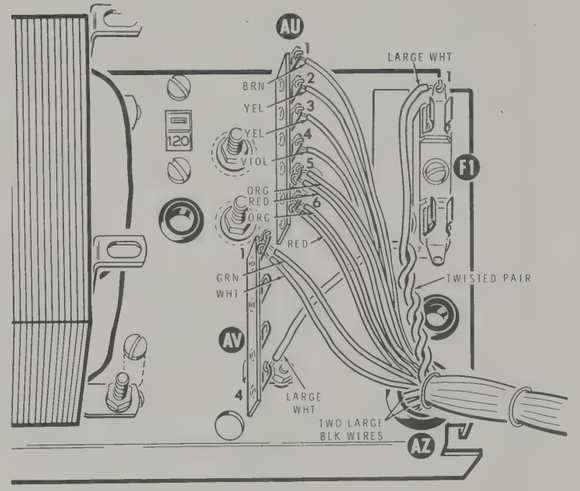




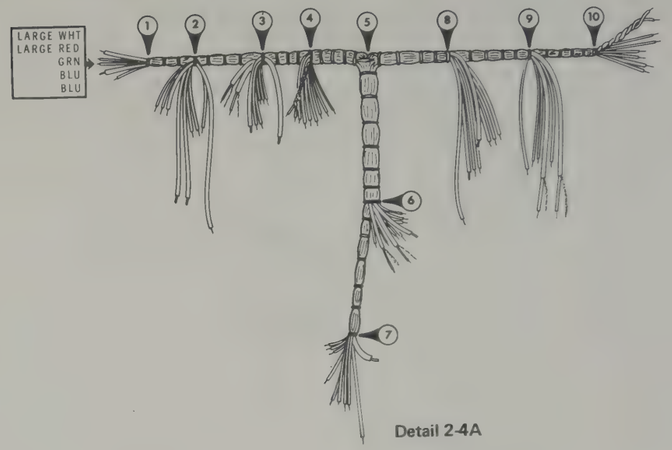
PICTORIAL 2-6



PICTORIAL 2-5



PICTORIAL 2-4



Detail 2-4A

Refer to Pictorial 2-4 for the following steps.

( ) Refer to Detail 2-4A and straighten out the wiring harness. Note the various places the individual wires leave the harness. These are called breakouts and serve as wire locators in the assembly steps.

( ) Pass the wire harness from the front of the rear panel through grommet AZ. Begin at breakout #1 and continue until breakout #4 is flush with the panel. Also pass the two large black wires from breakout #4 through grommet AZ.

( ) Fold the wires behind the rear panel over against the panel so you can lay the panel down on your work surface.

( ) Unwind the large white twisted wire pair so that the free ends are approximately 2" long.

NOTE: Make sure the next two wires you connect are mechanically secure before you solder them.

Connect the wires coming from breakout #4 as follows. Position the wires as shown.

( ) Either large white wire to fuseholder F1 lug 1 (S-1).

( ) Other large white wire to terminal strip AV lug 4 (S-4).

( ) Small white wire to terminal strip AV lug 1 (NS).

( ) Small green wire to terminal strip AV lug 1 (S-3).

Connect the remaining wires coming from breakout #4 to terminal strip AU as follows:

( ) Either red wire to lug 6 (NS).

( ) Either orange wire to lug 6 (S-3).

( ) Other red wire to lug 5 (NS).

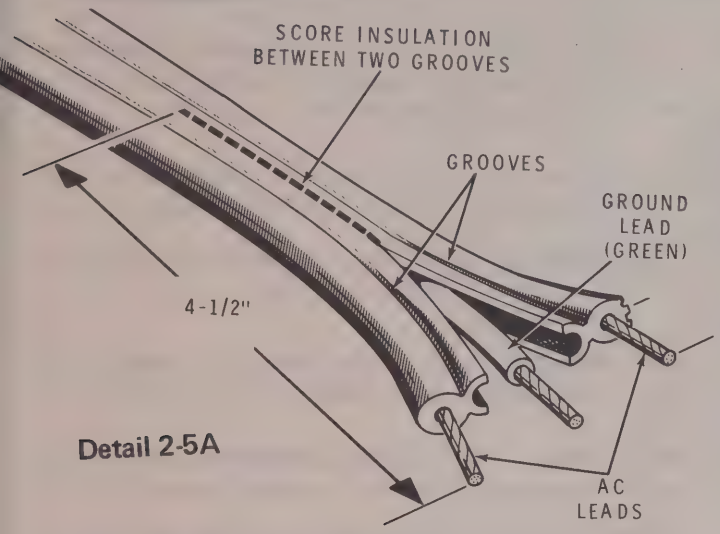
( ) Other orange wire to lug 5 (S-3).

( ) Violet wire to lug 4 (S-1).

( ) Either yellow wire to lug 3 (S-2).

( ) Other yellow wire to lug 2 (S-2).

( ) Brown wire to lug 1 (S-2).



Detail 2-5A

Refer to Pictorial 2-5 for the following steps.

NOTE: This instrument can be operated from a 120 VAC or a 240 VAC power source.

( ) Use a screwdriver to set switch SW2 to the position that will match your line voltage. For 120 VAC operation, set it so "120" is visible. For 240 VAC operation, set it so "240" is visible.

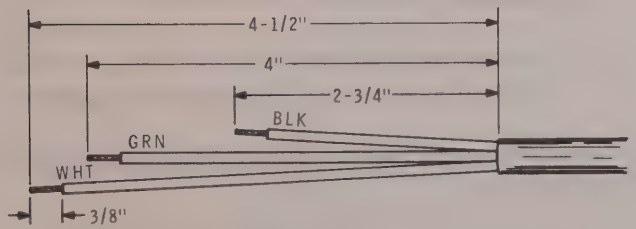
CAUTION: Electrical regulations in some areas require a special line cord and/or plug for 240-volt operation. If this cord and plug are not approved for your area, obtain an approved cord and plug locally and proceed with the following steps, making changes as necessary.

( ) Refer to Detail 2-5A and split the outer insulation of the line cord as shown so you do not cut into the protective insulation for the AC leads.

1. Use a knife point to score a line as shown, BETWEEN the two grooves.

2. Turn the cord over and repeat step 1.

3. Grasp the lead ends by the insulation and pull the leads apart. The line cord will separate on the scored lines.



Detail 2-5B

( ) Refer to Detail 2-5B and prepare the line cord wires. NOTE: Be sure to melt a small amount of solder on the wire ends after they are prepared.

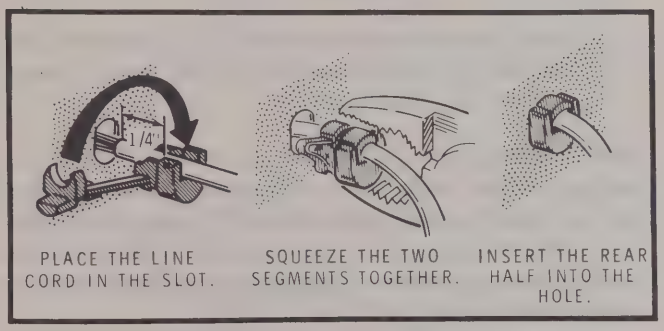
( ) Pass the prepared line cord wires through hole A1 and grommet AX.

NOTE: In the next three steps, make a mechanically secure connection with each line cord wire before you solder it.

( ) Connect the white wire to terminal strip AV lug 2 (S-4).

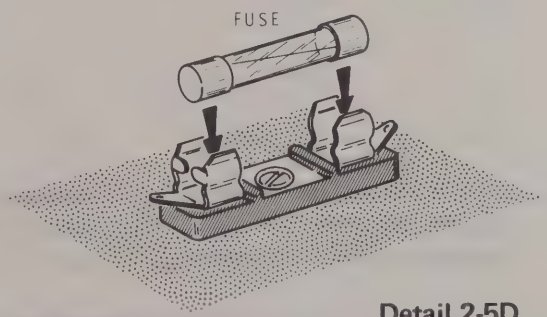
( ) Connect the green wire to solder lug AW (S-1).

( ) Connect the black wire to fuseholder F1 lug 2 (S-1).



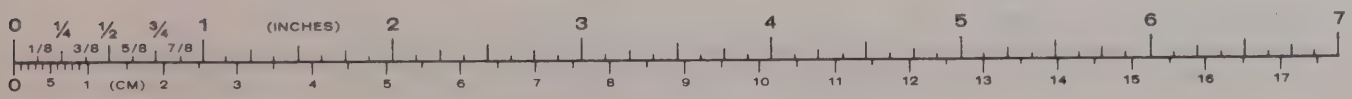
Detail 2-5C

( ) Secure the line cord to the rear panel with the line cord strain relief as shown in Detail 2-5C. NOTE: Because of the thickness of the line cord, it will be necessary to apply a great amount of pressure when you squeeze the strain relief segments together. Use a large pair of pliers.



Detail 2-5D

( ) Refer to Detail 2-5D and install the required fuse: 3-ampere for 120-volt operation or 1-1/2-ampere for 240-volt operation.

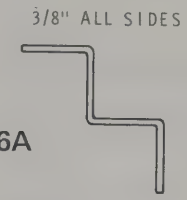


Refer to Pictorial 2-6 (fold-out from Page 34) for the following steps.

( ) Position the back of the rear panel toward you.

NOTE: It may be necessary to crimp the bare wire ends of large stranded wires before they will fit into a mounting lug or eyelet.

( ) Connect either large black wire coming from breakout #4 to the eyelet below lug 4 of terminal strip AU (S-1).

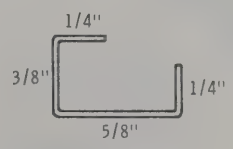


Detail 2-6A

( ) Refer to Detail 2-6A and bend a 1-1/2" large bare wire into the indicated shape. NOTE: The detail is drawn to scale, for a bend reference.

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection. Be especially careful, when you solder these connections, to apply enough solder and heat to solder these "through wires."

( ) Fit one end of the prepared bare wire into the eyelet below lug 2 of terminal strip AU (S-1) and the other end through solder lugs D11 (S-2) and D21 (S-1). It will be necessary to deform the wire to install it, but then return it to the original shape. NOTE: A large amount of heat will be required to solder these solder lugs at D11 and D21.



Detail 2-6B

( ) Refer to Detail 2-6B and bend a 1-1/2" large bare wire into the indicated shape. NOTE: The detail is drawn to scale, for a bend reference.

( ) Pass the 5/8" portion of the prepared bare wire through terminal strip AU lug 4 (NS) so that the 3/8" portion engages lug 3 (NS) and the other end of the 5/8" portion engages the eyelet of diode D21 (S-1) as shown.

( ) C21: Connect the lead from the positive (+) end of the 1.5 μF electrolytic capacitor to terminal strip AU lug 2 (NS). Connect the other lead to lug 3 (NS).

( ) Connect the other large black wire coming from breakout #4 to terminal strip AU lug 3 (S-3).

( ) Connect the large orange wire coming from breakout #3 to terminal strip AU lug 2 (S-2).

( ) Connect the large red wire coming from breakout #3 to the eyelet of diode D11 (S-1).

NOTE: Make a mechanically secure connection with each wire from grommet AT before you solder the wire.

( ) Connect the green wire coming from grommet AT to switch SW2 lug 1 (S-1).

( ) Connect the black-green wire coming from grommet AT to switch SW2 lug 2 (S-1).

( ) Connect the large white wire coming from grommet AT to switch SW2 lug 6 (S-1).

( ) Connect the black-yellow wire coming from grommet AT to switch SW2 lug 5 (S-1).

( ) Prepare a 6" large black stranded wire.

( ) Connect one end of the 6" large black stranded wire to terminal strip AU lug 4 (S-3). The other end will be connected later.

The remaining wires coming from breakout #3 will be connected later.

Refer to Pictorial 2-7 for the following steps.

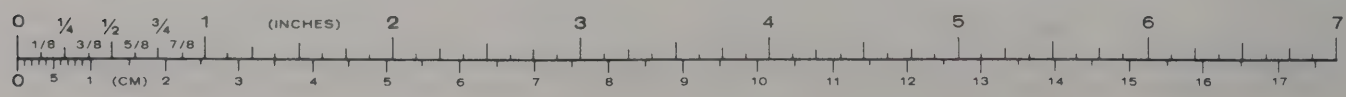
( ) Tighten the screws in a 7-lug barrier strip.

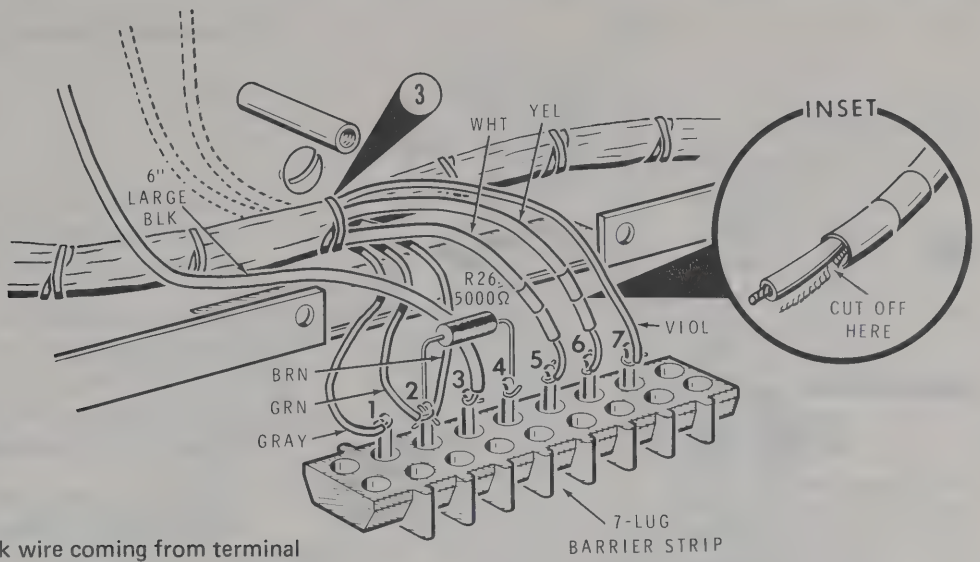
( ) R26: Connect the 5000 Ω (5k), precision resistor between barrier strip lugs 2 (NS) and 4 (S-1). NOTE: Position the resistor approximately 1/4" above the barrier strip lugs.

( ) Position this 7-lug barrier strip in front of the wires coming from breakout #3 of the harness as shown.

Connect the wires coming from breakout #3 to the barrier strip as follows:

( ) Gray wire to lug 1 (S-1).





PICTORIAL 2-7

( ) Green wire to lug 2 (NS).

( ) Brown wire to lug 2 (S-3).

( ) Connect the 6" large black wire coming from terminal strip AU lug 4 to lug 3 (S-1).

( ) Refer to the inset drawing in Pictorial 2-7 and cut off the shield wire from the white-banded shielded cable where it enters the insulation. Connect the cable to lug 5 (S-1).

( ) In a like manner, cut off the shield wire from the yellow-banded shielded cable where it enters the insulation, and connect the inner lead to lug 6 (S-1).

( ) Violet wire to lug 7 (S-1).

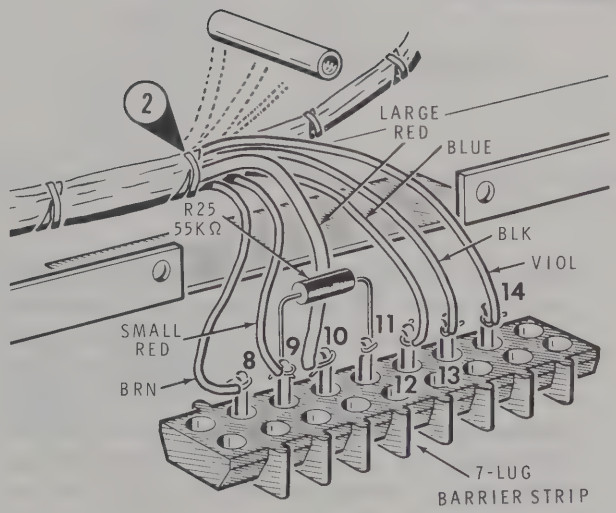
This barrier strip will be mounted to the rear panel in a later step.

Refer to Pictorial 2-8 for the following steps.

( ) Tighten the screws in a 7-lug barrier strip.

( ) R25: Connect the 55 kΩ, precision resistor between barrier strip lugs 9 (NS) and 11 (S-1). NOTE: Position the resistor approximately 1/4" above the barrier strip lugs.

( ) Position this 7-lug barrier strip in front of the wires from breakout #2 of the harness, as shown.



PICTORIAL 2-8

Connect the wires coming from breakout #2 to the barrier strip as follows:

( ) Brown wire to lug 8 (S-1).

( ) Small red wire to lug 9 (S-2).

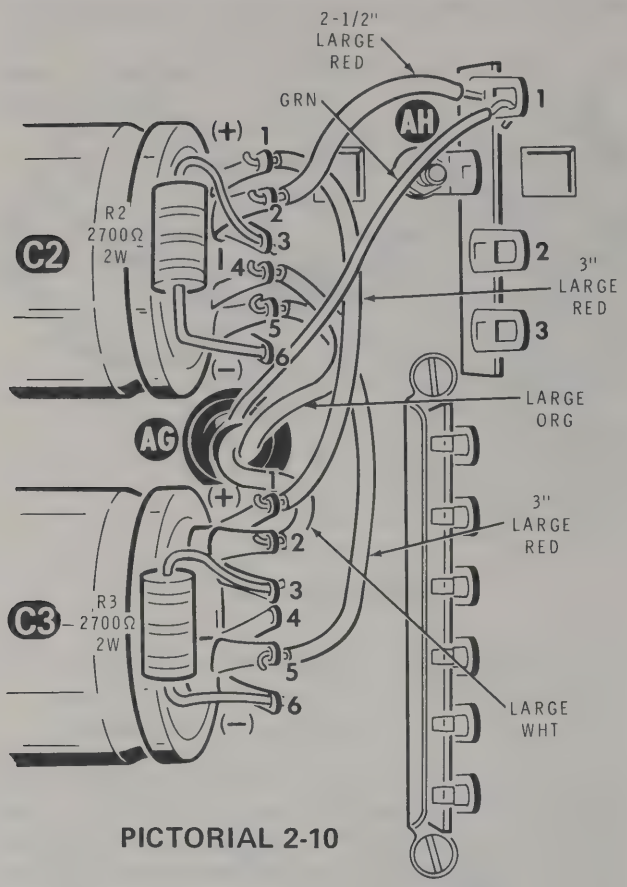
( ) Large red wire to lug 10 (S-1).

( ) Blue wire to lug 12 (S-1).

( ) Black wire to lug 13 (S-1).

( ) Violet wire to lug 14 (S-1).

The remaining wires from breakout #2 will be connected later.



PICTORIAL 2-10

Refer to Pictorial 2-9 (fold-out from Page 39) for the following steps.

( ) Mount the barrier strip connected to breakout #3 to the rear panel at A2 and A3. Use a 6-32 x 7/8" screw, two #6 lockwashers, a 6-32 nut, two #6 flat washers, and a 6-32 thumbnut at A2 and a 6-32 x 1/2" screw, #6 lockwasher, and 6-32 nut at hole A3. NOTE: Tighten the hardware at A2 before you install the two flat washers and thumbnut. Use the hole in the rear panel directly behind hole A2 to tighten the 7/8" screw with a screwdriver.

( ) Mount the barrier strip connected to breakout #2 to the rear panel at A4 and A5 with two 6-32 x 1/2" screws, #6 lockwashers, and 6-32 nuts.

( ) Pass the three wires coming from breakout #2 (large white, large orange, and green) through grommet AG.

Refer to Pictorial 2-10 for the following steps.

( ) Position the rear panel as shown.

( ) Prepare the following large red stranded wires:

2-1/2"
3"
3"

( ) Connect one end of the 2-1/2" large red wire to the eyelet below terminal strip AH lug 1 (S-1). Connect the other end of the wire to capacitor C2 lug 2 (S-1).

( ) Connect a 3" large red wire from capacitor C2 lug 1 (S-1) to capacitor C3 lug 1 (S-1).

( ) Connect one end of a 3" large red wire from capacitor C2 lug 5 (S-1) to capacitor C3 lug 5 (S-1).

( ) Connect the large white wire coming from grommet AG to capacitor C3 lug 2 (S-1).

( ) Connect the large orange wire coming from grommet AG to capacitor C2 lug 4 (S-1).

( ) Connect the green wire coming from grommet AG to termainal strip AH lug 1 (S-3).

( ) R2: Connect a 2700 Ω, 2-watt resistor (red-violet-red) to capacitor C2 between lugs 3 (S-1) and 6 (S-1). Cut off any excess resistor lead lengths.

( ) R3: Connect a 2700 Ω, 2-watt resistor (red-violet-red) to capacitor C3 between lugs 3 (S-1) and 6 (S-1). Cut off any excess resistor lead lengths.

( ) Carefully examine both capacitors to make sure the positive post solder lugs do not touch the negative post solder lugs.

( ) Position the wires from grommet AG down against the rear panel.

Set this panel aside until it is called for in a later step.

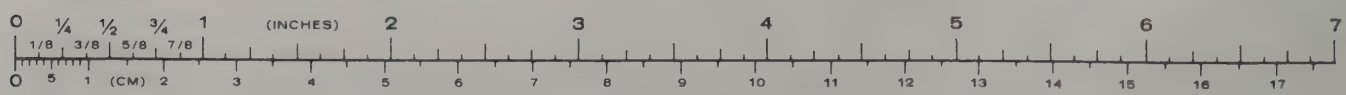
MIDDLE PANEL ASSEMBLY

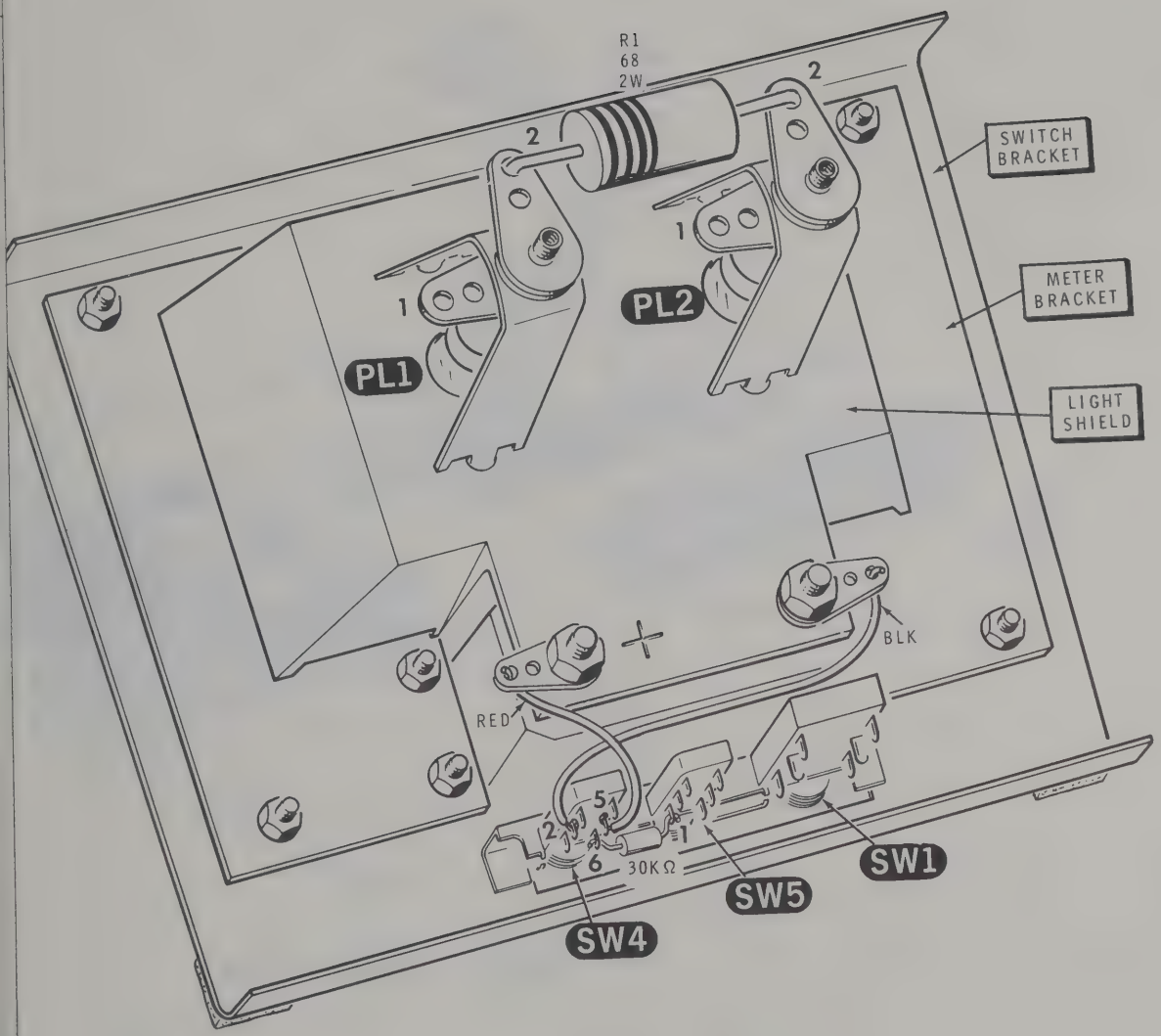
Refer to Pictorial 3-1 for the following steps.

( ) Position the middle panel as shown. It will be mounted to the transformer in a later step.

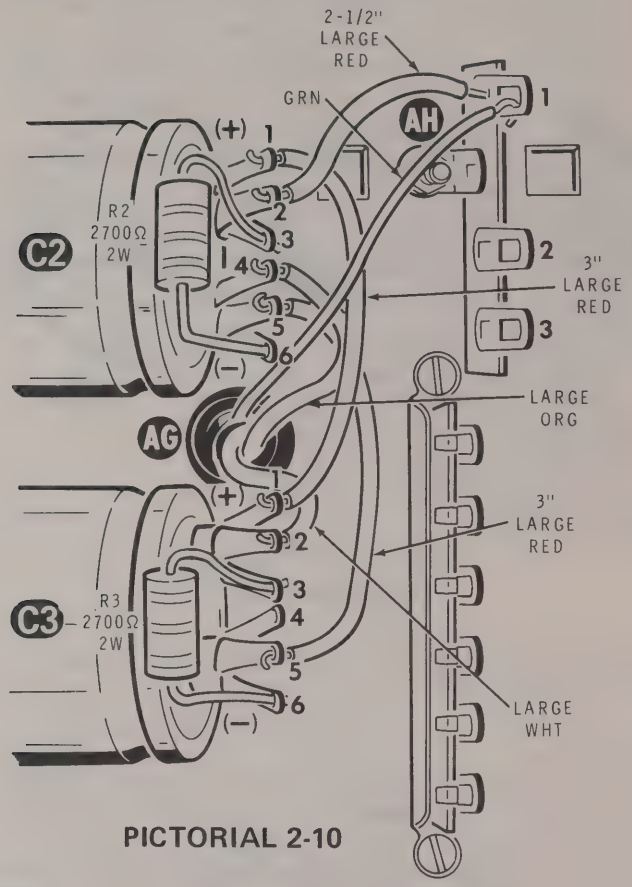
( ) Refer to Detail 3-1A and install 3/4" plastic grommets at BA and BB. They can be installed from either side of the panel.

( ) Refer to Detail 3-1B and install the four circuit board supports at BC, BD, BG, and BH. Position the supports as shown. NOTE: Be sure to use the correct holes.





PICTORIAL 3-3



PICTORIAL 2-10

Refer to Pictorial 2-9 (fold-out from Page 39) for the following steps.

( ) Mount the barrier strip connected to breakout #3 to the rear panel at A2 and A3. Use a 6-32 x 7/8" screw, two #6 lockwashers, a 6-32 nut, two #6 flat washers, and a 6-32 thumbnut at A2 and a 6-32 x 1/2" screw, #6 lockwasher, and 6-32 nut at hole A3. NOTE: Tighten the hardware at A2 before you install the two flat washers and thumbnut. Use the hole in the rear panel directly behind hole A2 to tighten the 7/8" screw with a screwdriver.

( ) Mount the barrier strip connected to breakout #2 to the rear panel at A4 and A5 with two 6-32 x 1/2" screws, #6 lockwashers, and 6-32 nuts.

( ) Pass the three wires coming from breakout #2 (large white, large orange, and green) through grommet AG.

Refer to Pictorial 2-10 for the following steps.

( ) Position the rear panel as shown.

( ) Prepare the following large red stranded wires:

2-1/2"
3"
3"

( ) Connect one end of the 2-1/2" large red wire to the eyelet below terminal strip AH lug 1 (S-1). Connect the other end of the wire to capacitor C2 lug 2 (S-1).

( ) Connect a 3" large red wire from capacitor C2 lug 1 (S-1) to capacitor C3 lug 1 (S-1).

( ) Connect one end of a 3" large red wire from capacitor C2 lug 5 (S-1) to capacitor C3 lug 5 (S-1).

( ) Connect the large white wire coming from grommet AG to capacitor C3 lug 2 (S-1).

( ) Connect the large orange wire coming from grommet AG to capacitor C2 lug 4 (S-1).

( ) Connect the green wire coming from grommet AG to termainal strip AH lug 1 (S-3).

( ) R2: Connect a 2700 Ω, 2-watt resistor (red-violet-red) to capacitor C2 between lugs 3 (S-1) and 6 (S-1). Cut off any excess resistor lead lengths.

( ) R3: Connect a 2700 Ω, 2-watt resistor (red-violet-red) to capacitor C3 between lugs 3 (S-1) and 6 (S-1). Cut off any excess resistor lead lengths.

( ) Carefully examine both capacitors to make sure the positive post solder lugs do not touch the negative post solder lugs.

( ) Position the wires from grommet AG down against the rear panel.

Set this panel aside until it is called for in a later step.

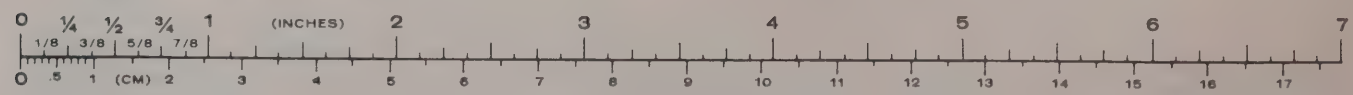
MIDDLE PANEL ASSEMBLY

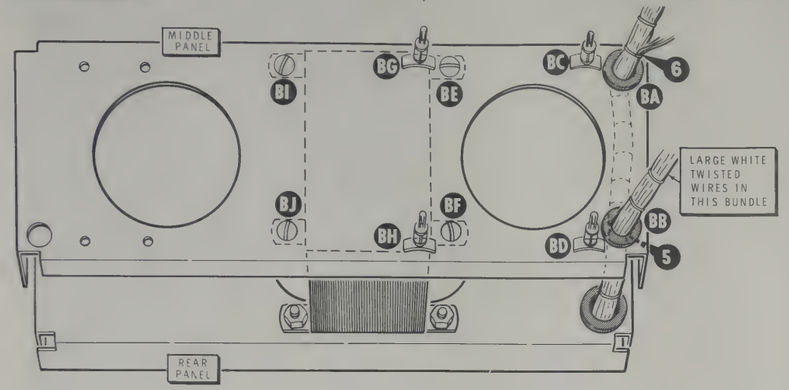
Refer to Pictorial 3-1 for the following steps.

( ) Position the middle panel as shown. It will be mounted to the transformer in a later step.

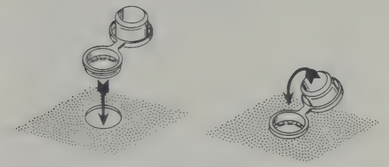
( ) Refer to Detail 3-1A and install 3/4" plastic grommets at BA and BB. They can be installed from either side of the panel.

( ) Refer to Detail 3-1B and install the four circuit board supports at BC, BD, BG, and BH. Position the supports as shown. NOTE: Be sure to use the correct holes.





PICTORIAL 3-1



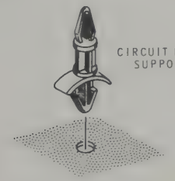
POSITION THE SMALL PORTION OF THE GROMMET INTO THE CHASSIS HOLE.

BEND THE LARGE PORTION OF THE GROMMET OVER AND INTO THE SMALL PORTION. PRESS IT FIRMLY INTO PLACE.

Detail 3-1A

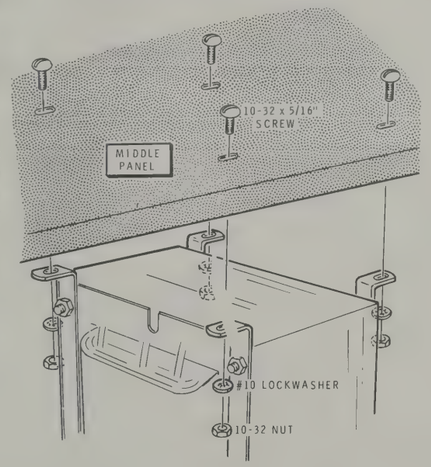
( ) Pass the wire harness coming from breakout #5 that contains breakouts #8, #9, and #10, through grommet BB. NOTE: These wires contain the large, white, twisted pair. Refer to Detail 2-4A on Page 34 for breakout identification.

( ) Pass the wires from breakouts #6 and #7 through grommet BA.

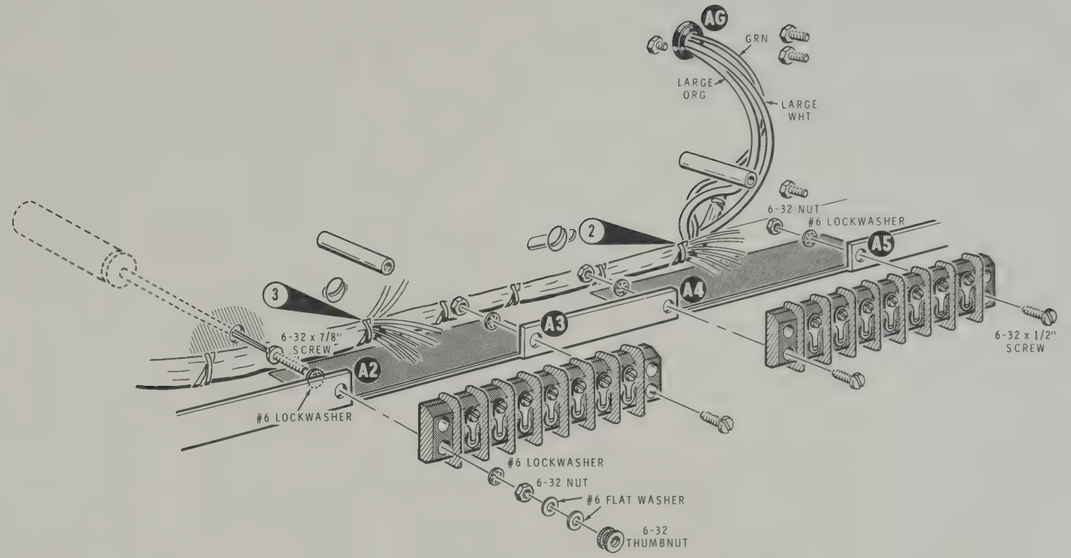


Detail 3-1B

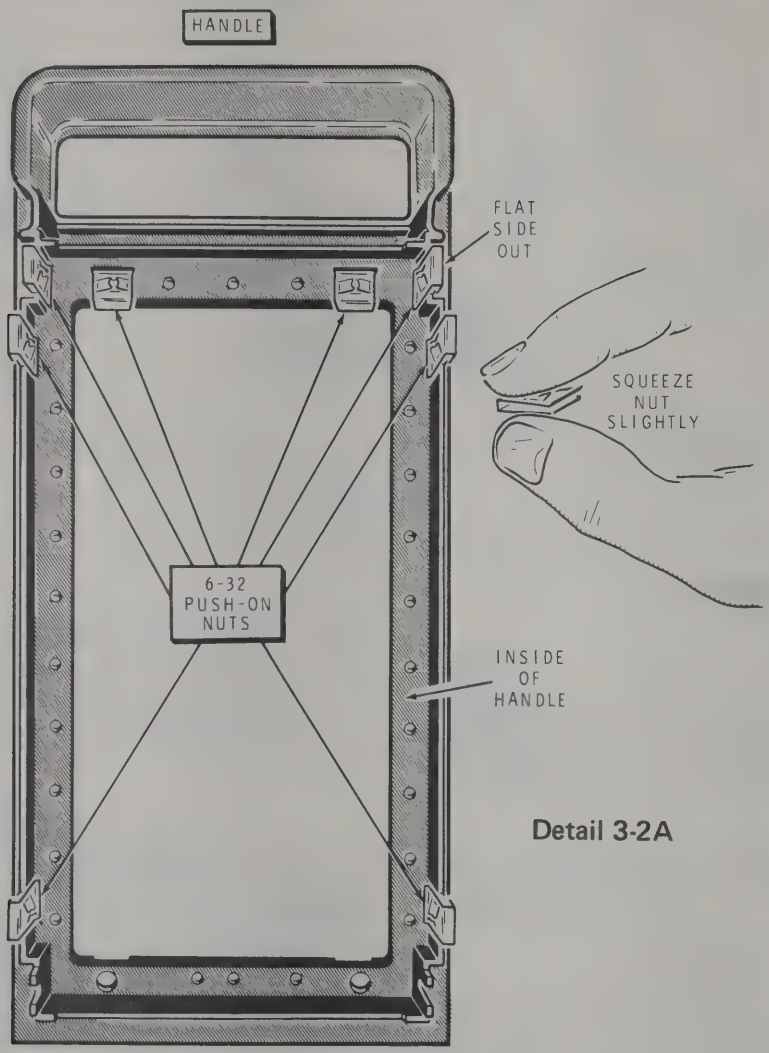
( ) Refer to Detail 3-1C and mount the middle panel to the power transformer with four 10-32 x 5/16" screws, four #10 lockwashers, and four 10-32 nuts. Do not tighten the nuts at this time.



Detail 3-1C



PICTORIAL 2-9



Detail 3-2A

Refer to Pictorial 3-2 for the following steps.

( ) Loosen the four rear panel transformer mounting screws. This will let you shift the middle and rear panels to "square up" the chassis in a later step.

NOTE: Place a soft cloth on your work surface to protect the handles from scratches.

( ) Refer to Detail 3-2A and install eight 6-32 push-on nuts onto each handle. Note that you must squeeze each nut slightly so that it will fit more securely onto the handle. Position the flat side of the nut to the outside of the handle.

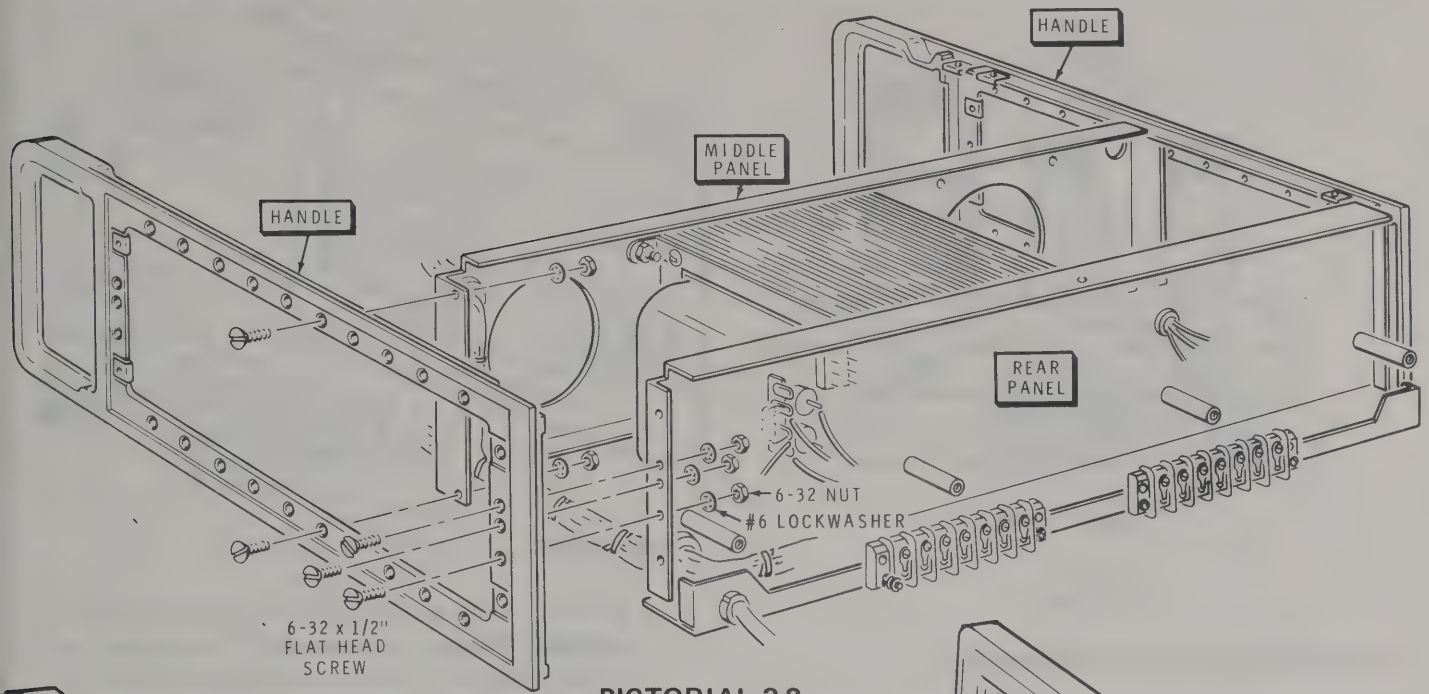
( ) Mount a handle to each side of the middle and rear panels with five 6-32 x 1/2" flat head screws, five #6 lockwashers, and five 6-32 nuts.

( ) Refer to Detail 3-2B and mount the top cover to the chassis assembly with four 6-32 x 3/8" flat head screws. Make sure the cover fits down onto the handles. This will "square up" the chassis.

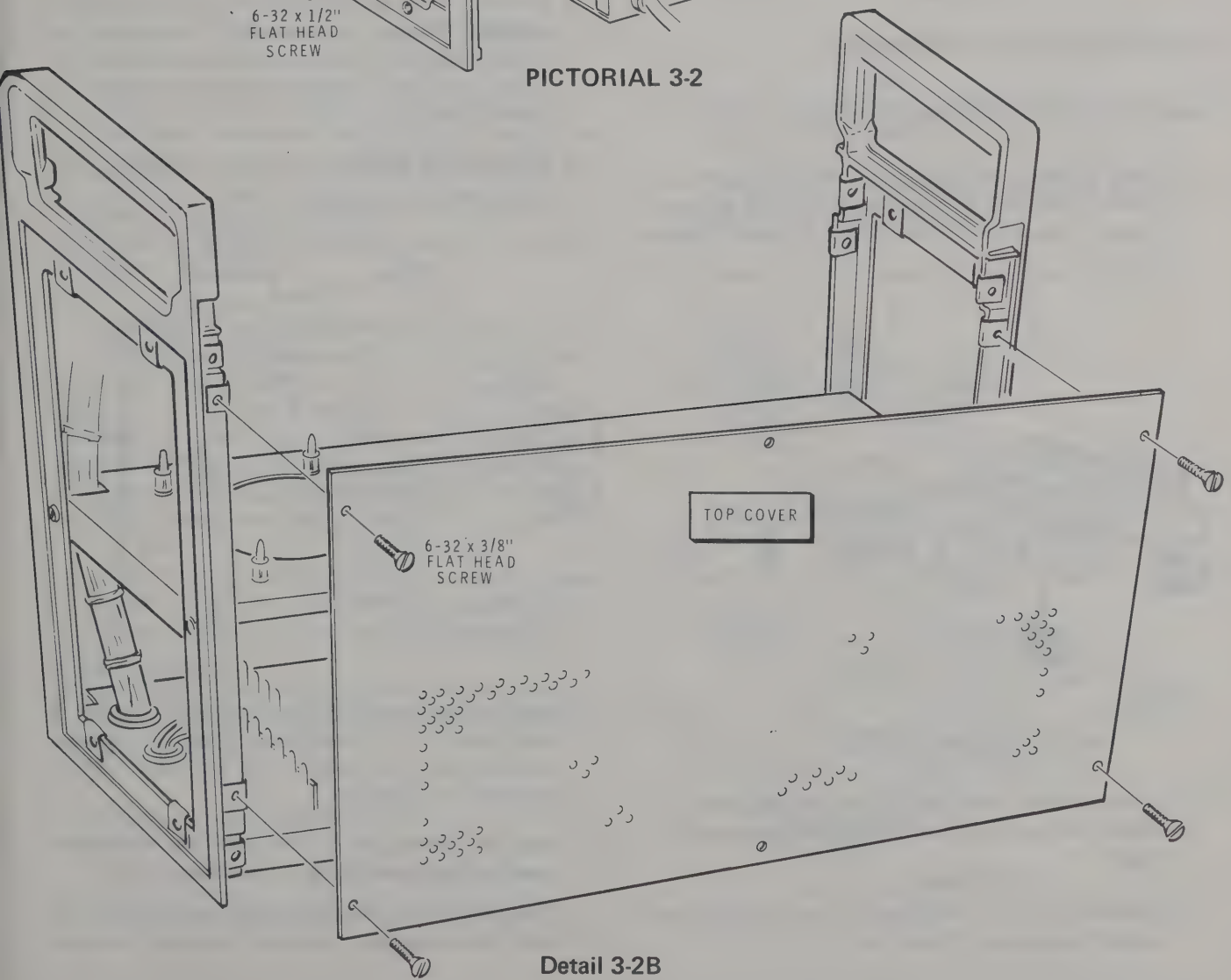
( ) Tighten the eight transformer mounting screws.

( ) Remove the top cover.

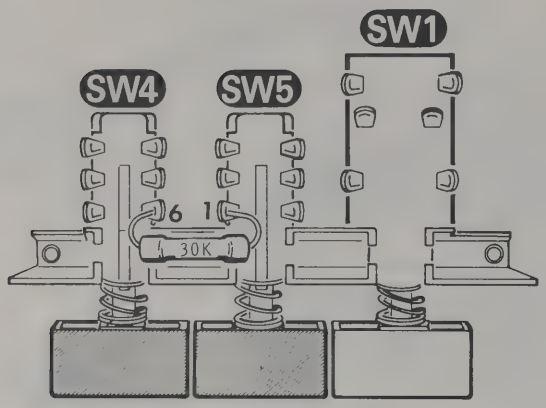
Temporarily set the chassis assembly aside.



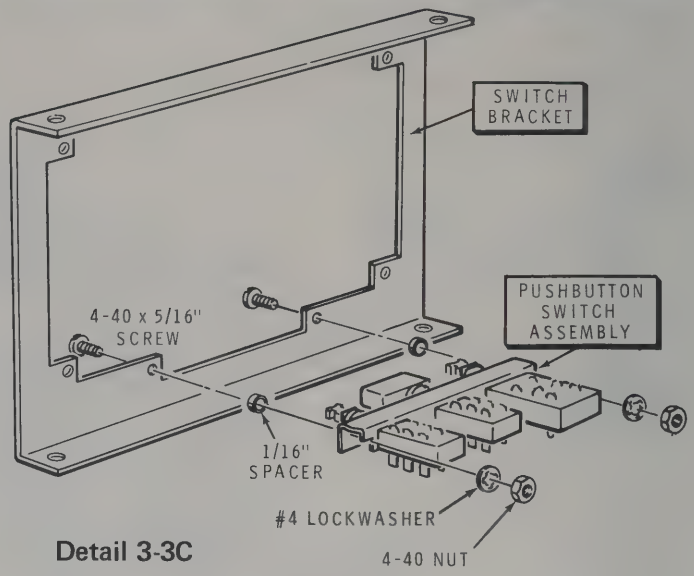
PICTORIAL 3-2



Detail 3-2B



Detail 3-3A

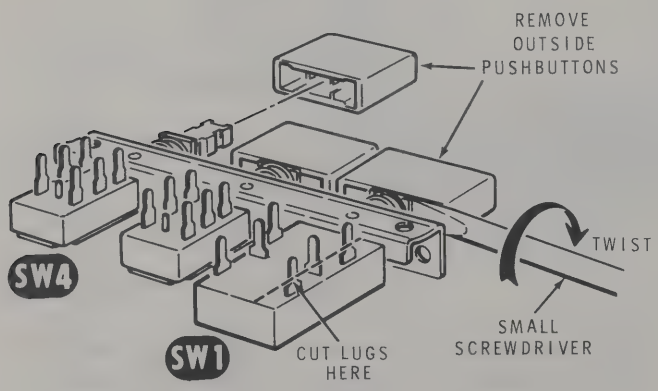


Detail 3-3C

METER AND SWITCH ASSEMBLY

Refer to Pictorial 3-3 for the following steps.

( ) R24: Position the pushbutton switch assembly as shown in Detail 3-3A and connect a 30 kΩ, precision resistor from switch SW4 lug 6 (S-1) to switch SW5 lug 1 (NS).



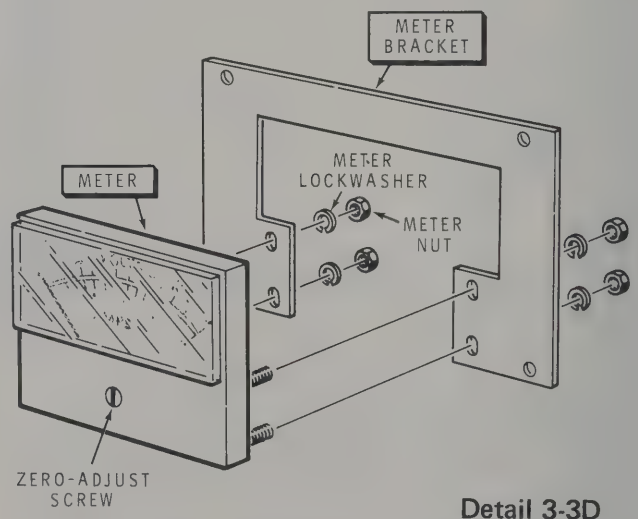
Detail 3-3B

( ) Refer to Detail 3-3B, position the switch assembly as shown, and cut off all of the switch lugs shown (18 lugs).

( ) Carefully pry the pushbutton off from switches SW4 and SW1 as shown in Detial 3-3B.

( ) Position the switch bracket and pushbutton switch assembly as shown in Detail 3-3C. Then mount the switch assembly to the bracket with two 4-40 x 5/16" screws, two 1/16" spacers, two #4 lockwashers, and two 4-40 nuts.

( ) Press the red pushbutton onto switch SW1 and the black pushbutton onto switch SW4.

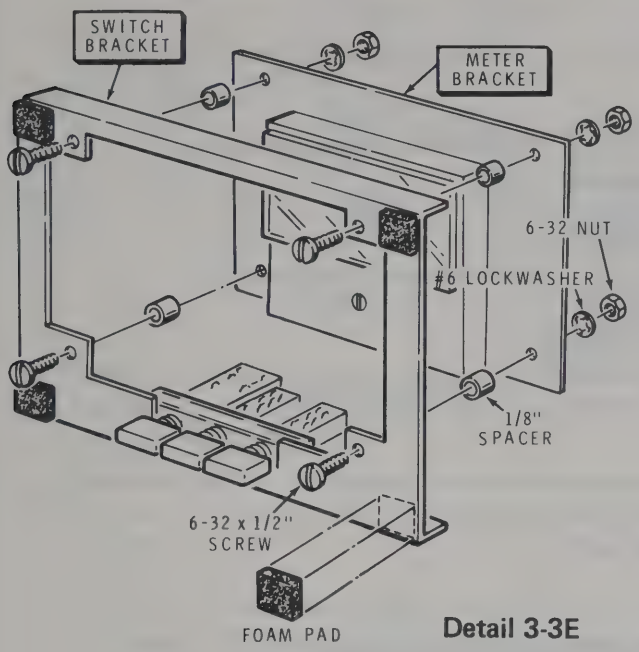


Detail 3-3D

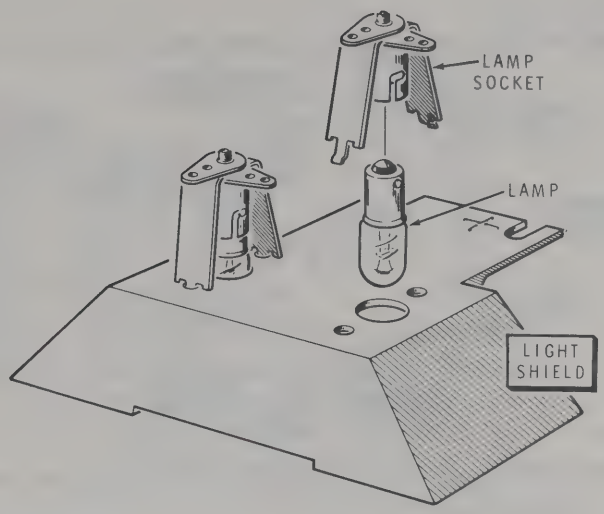
( ) Refer to Detail 3-3D and loosely mount the meter to either side of the meter bracket. Use the hardware supplied with the meter. The hardware will be tightened in a later step.

( ) Hold the meter upright and, with the zero-adjust screw, set the meter pointer to indicate zero.

( ) Cover the face of the meter with a piece of paper and tape. This will protect the meter from being scratched.



Detail 3-3E



Detail 3-3F

( ) Refer to Detail 3-3E and mount the meter bracket to the switch bracket with four 6-32 x 1/2" screws, four 1/8" spacers, four #6 lockwashers and four 6-32 nuts.

( ) Remove the paper backing from the four 1/2" x 1/2" foam pads and stick a pad to each corner of the switch bracket.

( ) PL1/PL2: Install a lamp into each of the two lamp sockets. Then install the sockets into the light shield as shown in Detail 3-3F.

( ) Refer to Detail 3-3G and remove the shorting wire from between the two meter posts. Then remove the two nuts, and solder lug from each post of the meter. Do not remove the meter washers.

( ) Mount the light shield to the meter and secure it with a nut on each post. Then install a meter lug on each post and secure them with the remaining two nuts.

( ) R1: Install a 68 Ω, 2-watt resistor (blue-gray-black) from lamp socket PL1 lug 2 (S-1) to lamp socket PL2 lug 2 (S-1).

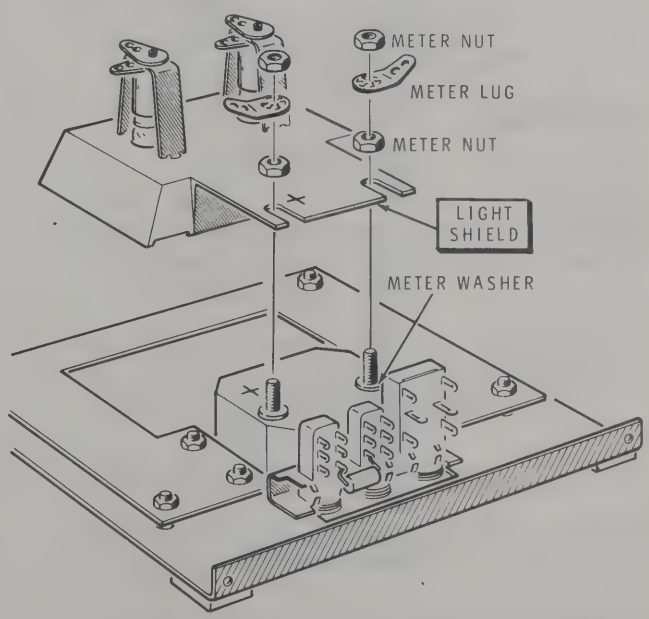
( ) Prepare the following solid wires:

2-1/2" red
4" black

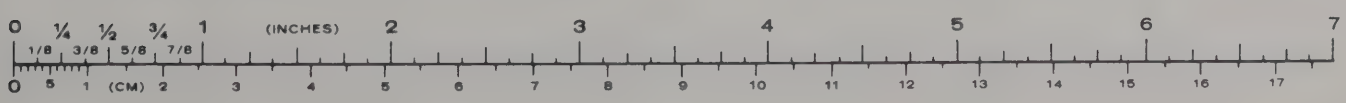
( ) Connect a 2-1/2" red wire from switch SW4 lug 5 (S-1) to the "+" solder lug on the meter (S-1).

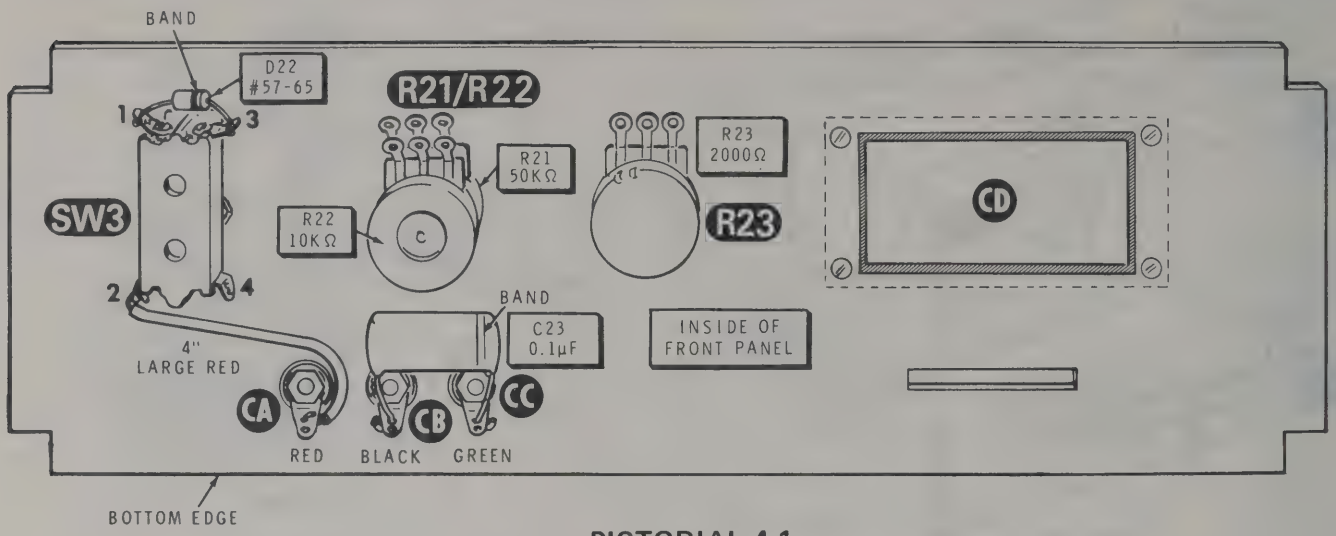
( ) Connect a 4" black wire from switch SW4 lug 2 (S-1) to the other lug on the meter (S-1).

Set the meter and switch assembly aside temporarily.

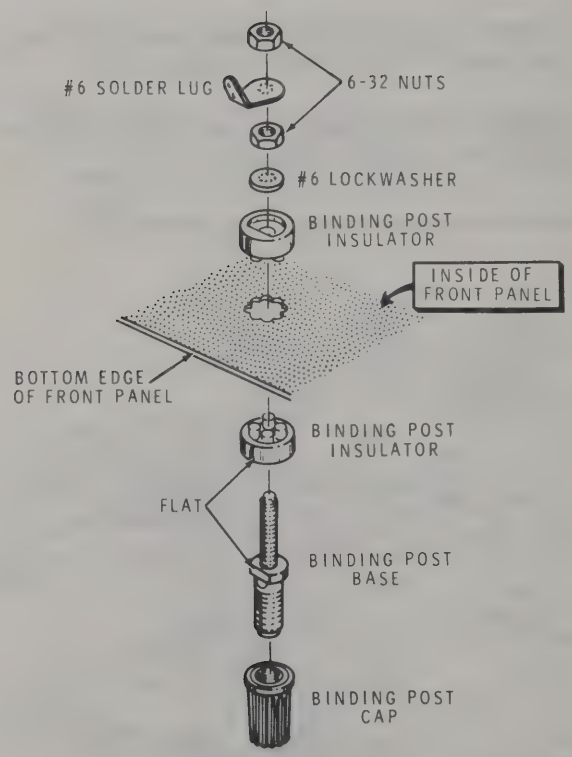


Detail 3-3G





PICTORIAL 4-1



Detail 4-1A

FRONT PANEL ASSEMBLY

Refer to Pictorial 4-1 for the following steps.

( ) Refer to Detail 4-1A and install the red binding post assembly at hole CA (+) as follows:

1. Press a red binding post insulator into the hole from each side of the front panel. (The flat on the outside insulator should be parallel with the bottom edge of the front panel.)

2. Insert the binding post base into the two insulators from the front.

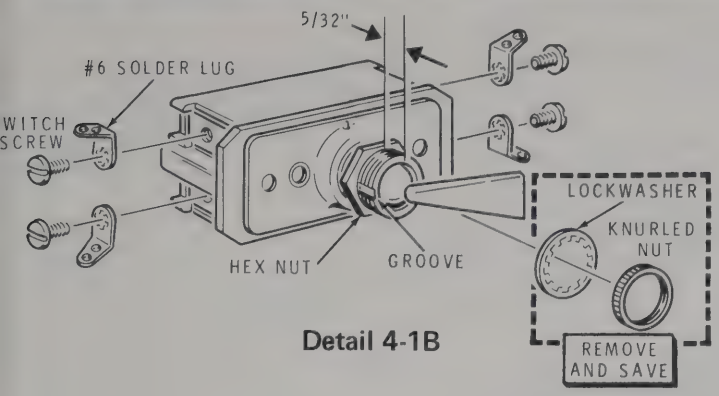
3. Place a #6 lockwasher over the small threads on the binding post base. Then secure the base with a 6-32 nut.

4. Place a #6 solder lug over the small threads on the binding post base. Then secure the solder lug with a 6-32 nut. NOTE: Position the solder lug toward the bottom edge of the front panel.

5. Screw the red binding post cap onto the binding post base.

( ) In like manner, install a black binding post assembly at hole CB (–).

( ) Similarly, install a green binding post assembly at hole CC (⏚).

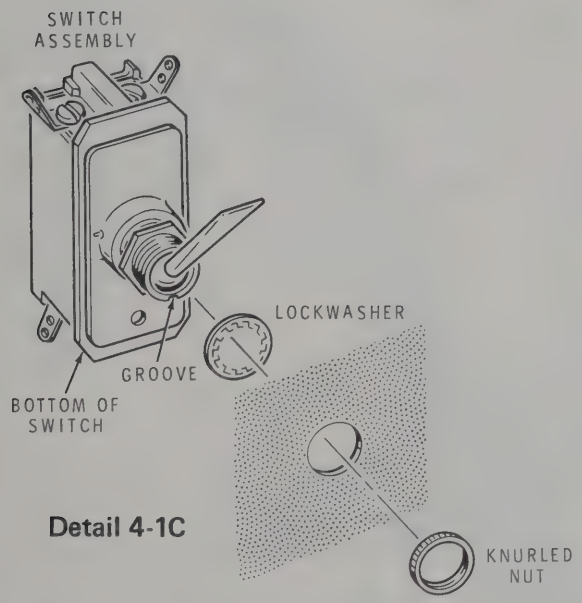


Detail 4-1B

( ) Refer to Detail 4-1B and remove the four switch screws from the toggle switch. Then reinstall each screw with a #6 solder lug.

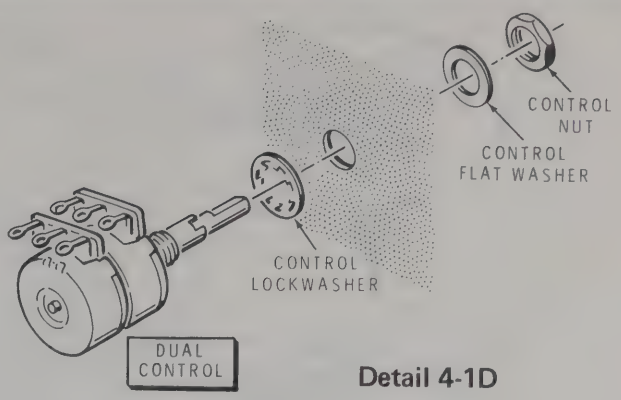
( ) Remove the knurled nut and lockwasher from the switch.

( ) Turn the hex nut until it is approximately 5/32" from the front edge of the threaded bushing. This will insure that the switch does not extend too far beyond the front panel after it is mounted.



Detail 4-1C

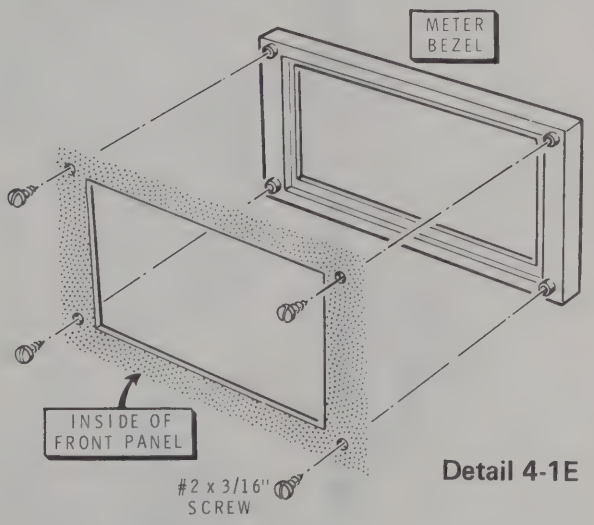
( ) Refer to Detail 4-1C and reinstall the lockwasher onto the switch threads. Then insert the switch into hole SW3 and secure it with the knurled nut. Be sure to position the groove, on the switch threads, toward the bottom edge of the front panel. NOTE: You will find it easier to install the switch if you screw on the knurled nut until it is flush with the end of the threads; then hold the switch body and tighten the hex nut against the front panel.



Detail 4-1D

( ) R21/R22: Refer to Detail 4-1D and mount the dual control (#12-137) at R21/R22 with a control lockwasher, control flat washer, and control nut. Position the control as shown in the Pictorial.

( ) R23: In like manner, mount the 2000 Ω (2k) control (#10-269) at hole R23.



Detail 4-1E

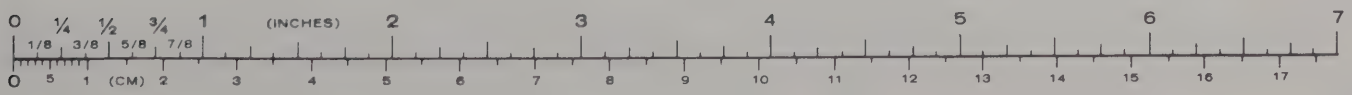
( ) Refer to Detail 4-1E and mount the meter bezel at CD with four #2 x 3/16" screws. NOTE: The screw holes are designed to allow the screw heads to recess into the front panel.

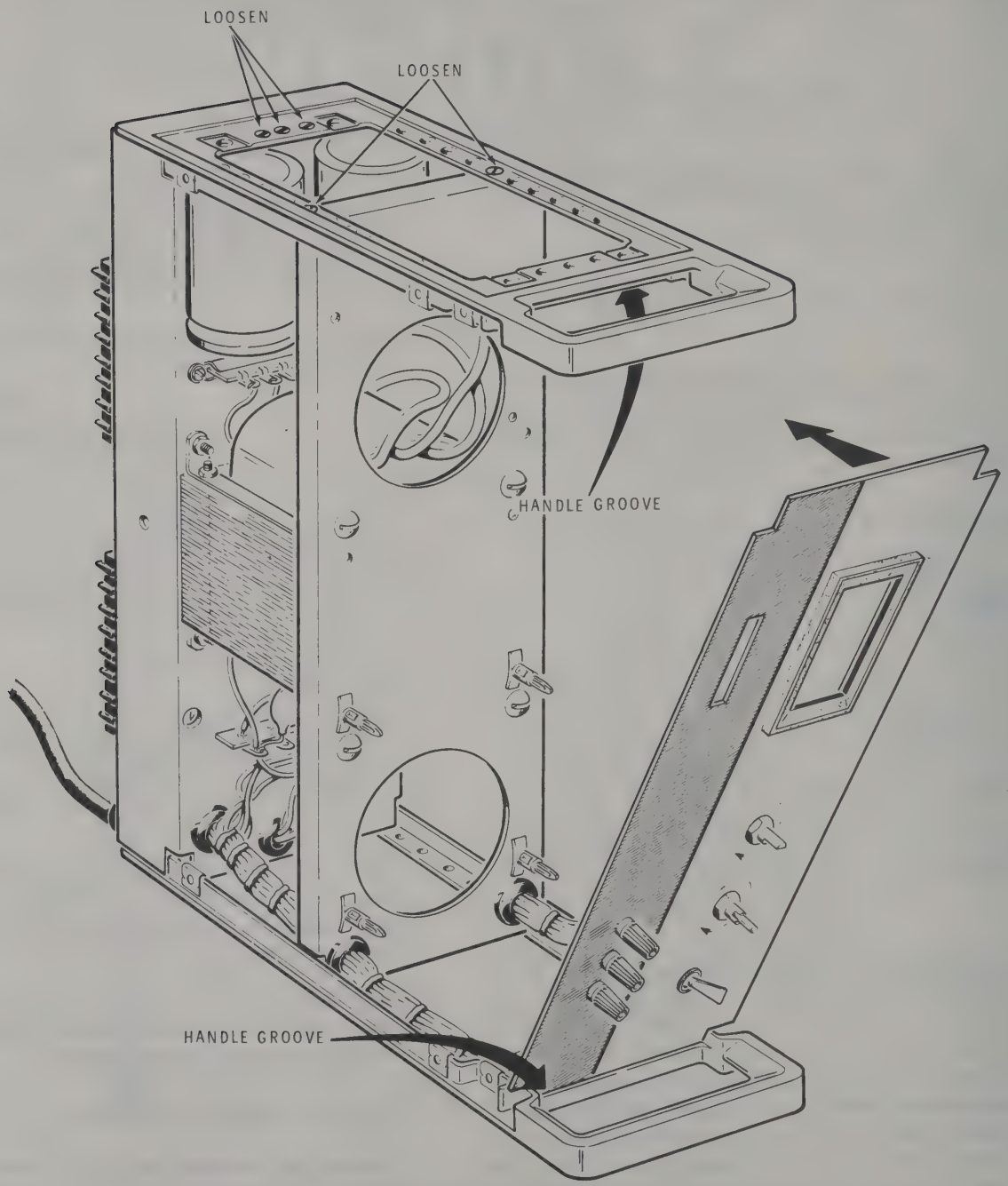
( ) D22: Carefully connect the lead at the banded end of the 1N4002 diode (#57-65) to switch SW3 lug 3 (NS). Connect the other lead to lug 1 (NS).

( ) Prepare a 4" large red stranded wire.

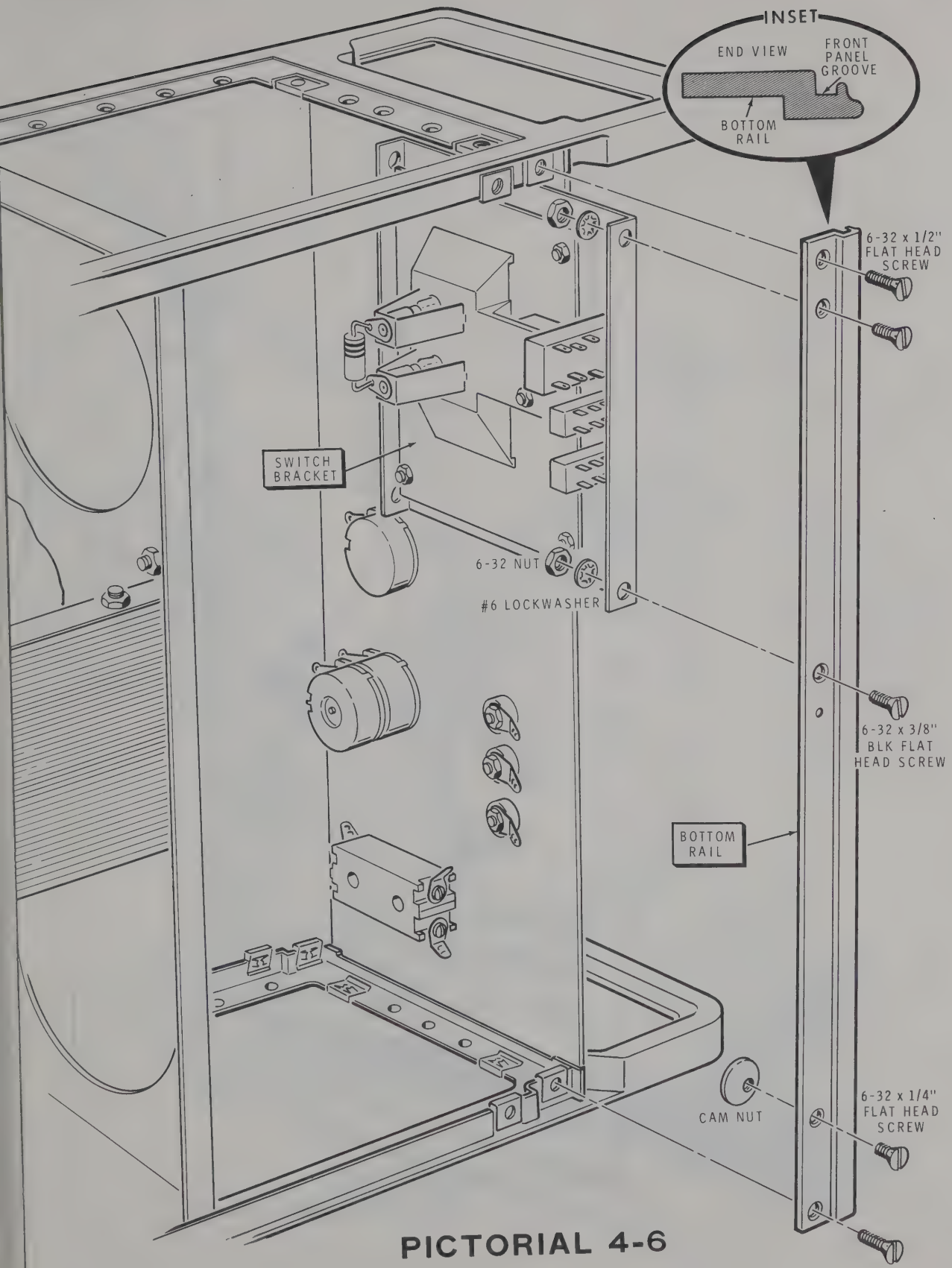
( ) Connect this red wire from switch SW3 lug 2 (NS) to solder lug CA (NS).

( ) C23: Connect the lead at the banded end of the 0.1 µF Mylar capacitor to solder lug CC (NS). Connect the other lead of the capacitor to solder lug CB (NS).

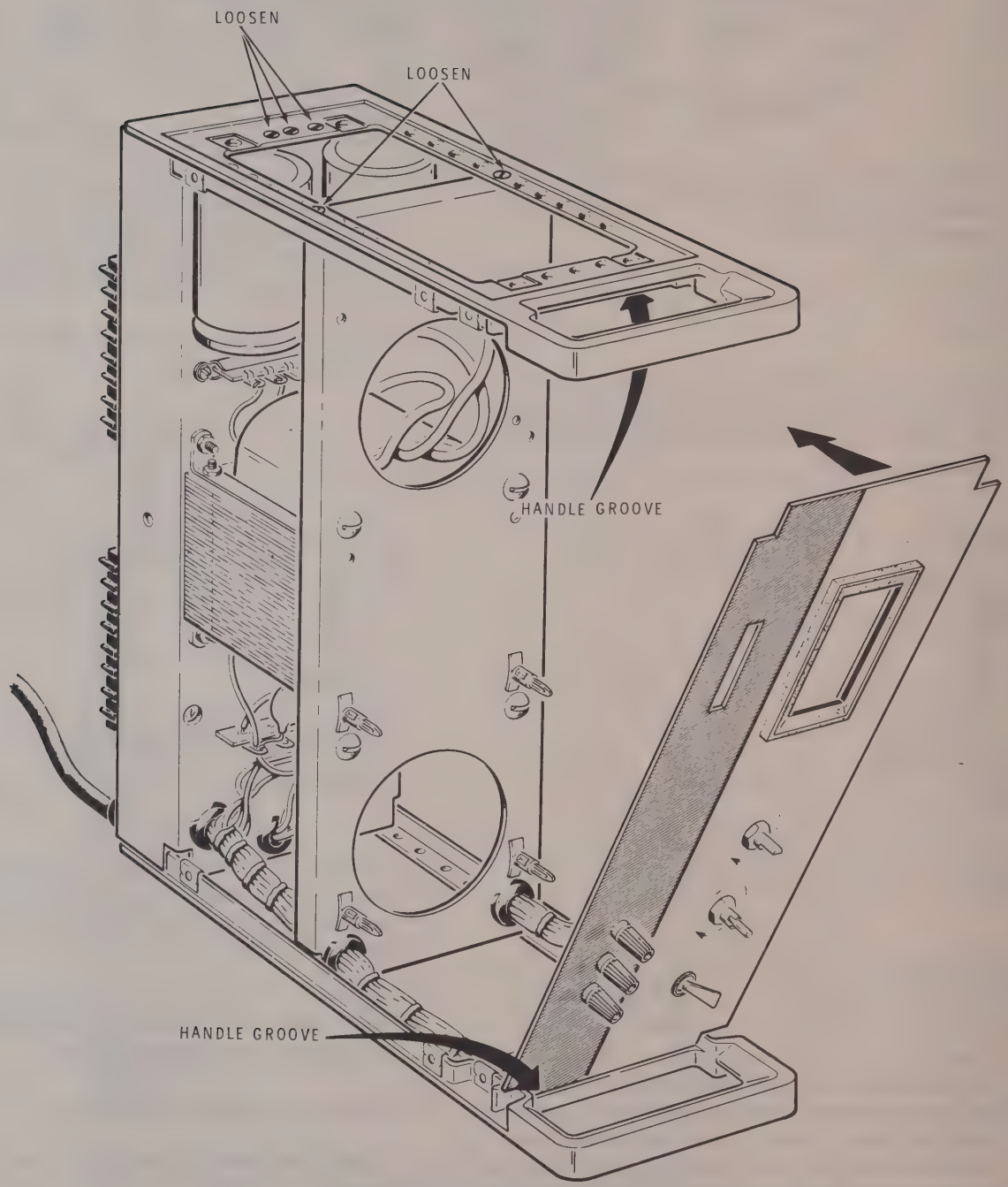




PICTORIAL 4-2



PICTORIAL 4-6



PICTORIAL 4-2

Refer to Pictorial 4-2 for the following steps.

( ) Position the chassis on its right side as shown.

( ) Loosen the five 6-32 x 1/2" flat head screws that secure the left handle to the rear panel.

( ) Position the front panel into the groove in the right handle as shown.

( ) Lift the left handle up and swing the front panel into the groove in the left handle.

( ) Retighten the five handle screws.

The front panel is loosely secured to the chassis by the two handles. It will be held more tightly when the remaining parts are secured to the chassis.

Refer to Pictorial 4-3 (fold-out from this page) for the following steps.

Connect the wires coming from breakout #8 as follows:

( ) Large red wire to switch SW3 lug 2 (S-2).

( ) Small red wire to switch SW3 lug 4 (S-1).

( ) Brown wire to solder lug CA (S-2). NOTE: High heat will be required on this connection. Cut off the excess wire after soldering.

( ) Large black wire to solder lug CB (NS).

NOTE: Cut off the excess wire after you complete the soldering in the next two steps.

( ) Gray wire to solder lug CB (S-3). NOTE: High heat will be required on this connection.

( ) Violet wire to solder lug CC (S-2).

Refer to Pictorial 4-4 (fold-out from this page) for the following steps.

Connect the remaining wires coming from breakout #8 as follows.

( ) Large orange wire to switch SW3 lug 1 (S-2).

( ) Small orange wire to switch SW3 lug 3 (NS).

( ) Green wire to switch SW3 lug 3 (S-3).

Connect the wires coming from breakout #9 as follows:

( ) Cut a 1-1/4" length of solid red wire (not from the wire harness) and remove the insulation.

( ) Refer to the inset drawing and connect this 1-1/4" bare wire from R21 lug 1 (S-1) through R22 lug 2 (S-2) to R22 lug 3 (S-1).

( ) Connect the inner lead of the white-banded shielded cable to R21 lug 2 (S-1).

( ) Cut a 5/8" length of sleeving and place it over the shield lead of the white-banded cable. Then connect the shield lead to R21 lug 3 (NS).

( ) Connect the inner lead of the black shielded cable to R22 lug 1 (S-1).

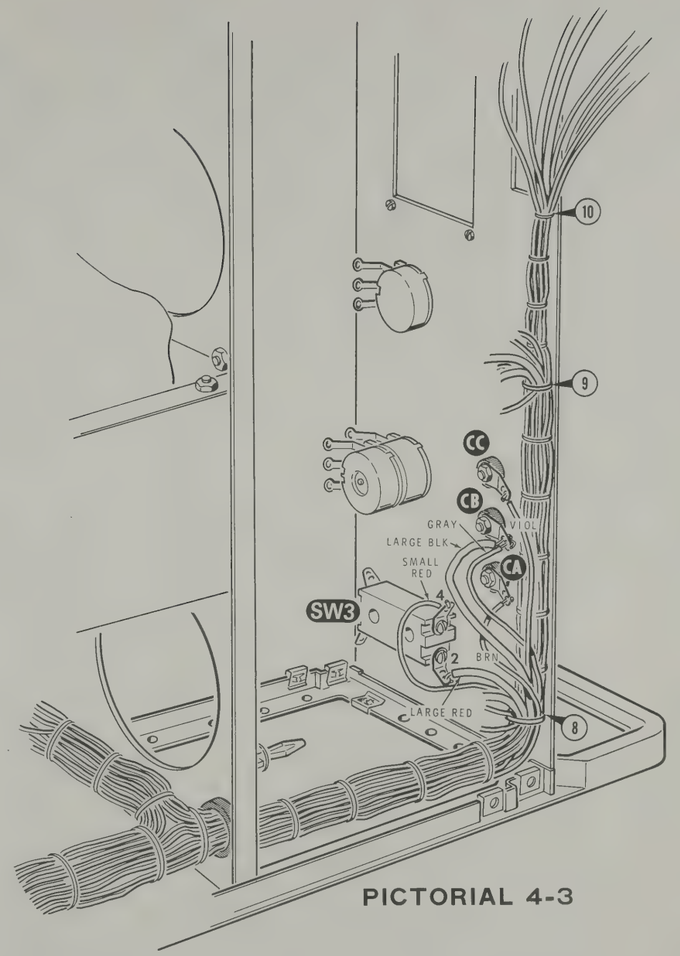
( ) Cut a 5/8" length of sleeving and place it over the shield lead of the black cable. Then connect the shield lead to R21 lug 3 (S-2).

( ) Connect the yellow wire to R23 lug 3 (NS).

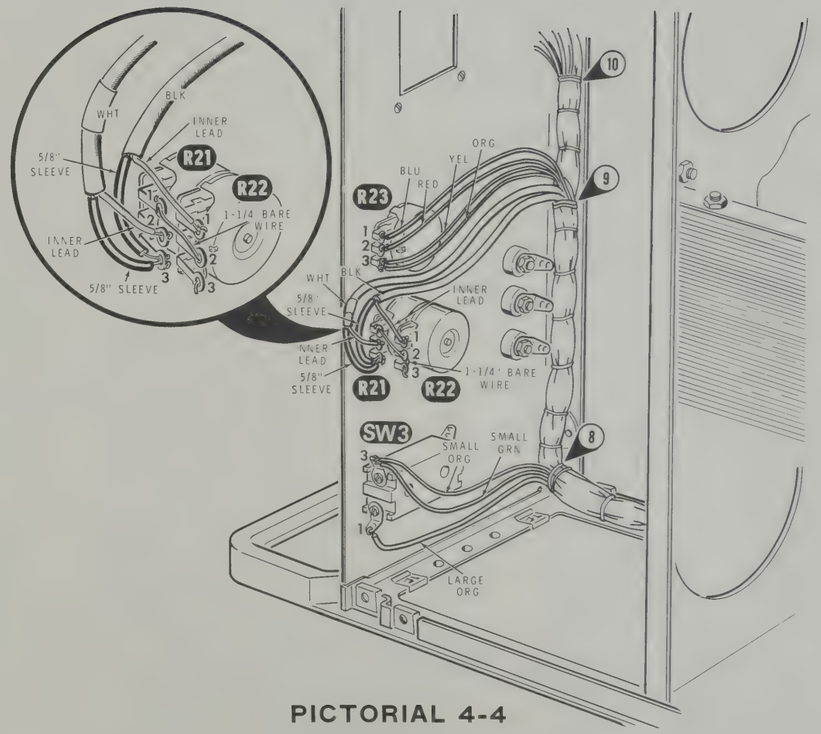
( ) Connect the orange wire to R23 lug 3 (S-2).

( ) Connect the red wire to R23 lug 2 (S-1).

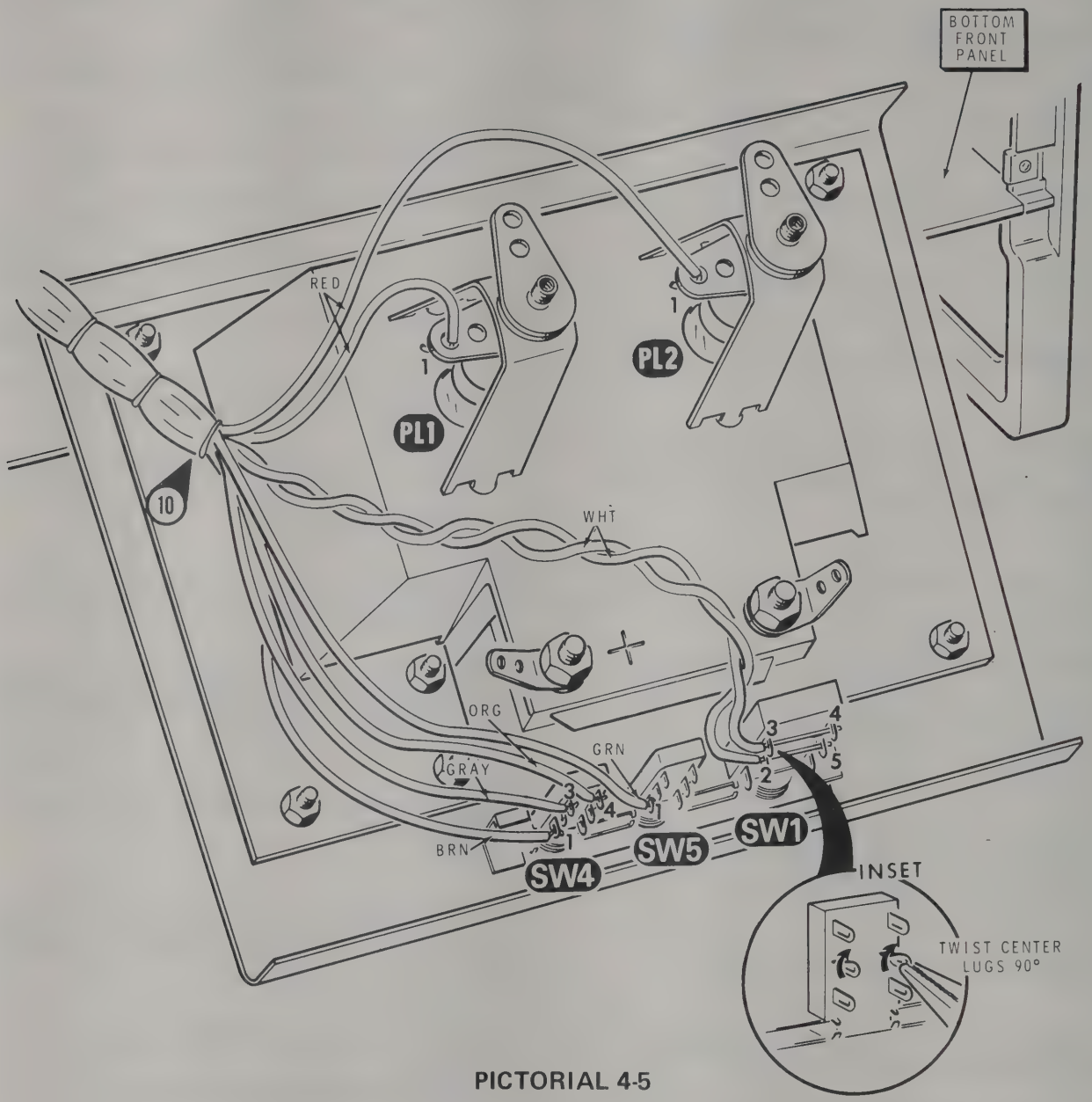
( ) Connect the blue wire to R23 lug 1 (S-1).



PICTORIAL 4-3



PICTORIAL 4-4



PICTORIAL 4-5

Refer to Pictorial 4-5 for the following steps.

Position the meter and switch assembly near the front panel and connect the wires from breakout #10 as follows:

( ) Either red wire to lamp socket PL2 lug 1 (S-1).

( ) Other red wire to lamp socket PL1 lug 1 (S-1).

( ) Remove an extra 3/8" of insulation from each wire of the white twisted pair. Then flatten the exposed wire so it will fit into the switch lugs.

( ) Refer to the inset drawing and twist the two center lugs (2 and 5) of switch SW1 90° so the lug holes are aligned.

Connect the remaining wires of breakout #10 as follows:

( ) Connect either white wire through switch SW1 lug 2 (S-2) to lug 5 (S-1).

( ) Connect the other white wire through switch SW1 lug 3 (S-2) to lug 4 (S-1).

( ) Connect the green wire to switch SW5 lug 1 (S-2). NOTE: Make sure the resistor has a good solder connection.

( ) Connect the orange wire to switch SW4 lug 4 (S-1).

( ) Connect the gray wire to switch SW4 lug 3 (S-1).

( ) Connect the brown wire to switch SW4 lug 1 (S-1).

Refer to Pictorial 4-6 (fold-out from Page 48) for the following steps.

( ) Refer to the inset drawing and locate the bottom rail.

( ) Position the bottom rail as shown and mount it to the handles with two 6-32 x 1/2" flat head screws. Be sure the front panel is seated in the groove.

( ) Position the meter and switch assembly behind the front panel (the meter must fit into the front panel cutout) and secure the switch bracket to the bottom rail with two 6-32 x 3/8" black flat head screws, #6 lockwashers, and 6-32 nuts. Check the switch buttons to see that they are centered in the panel opening. Shift the bracket if necessary.

( ) Loosely mount a cam nut to the bottom rail with a 6-32 x 1/4" flat head screw.

Refer to Pictorial 4-7 for the following steps.

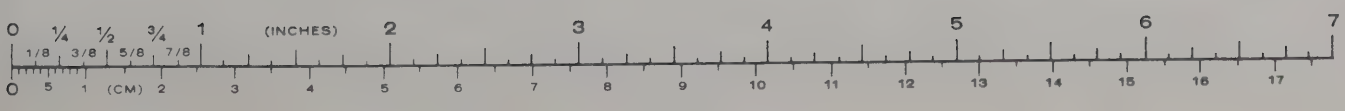
( ) Position the top rail as shown and mount it to the two handles with two 6-32 x 1/2" flat head screws.

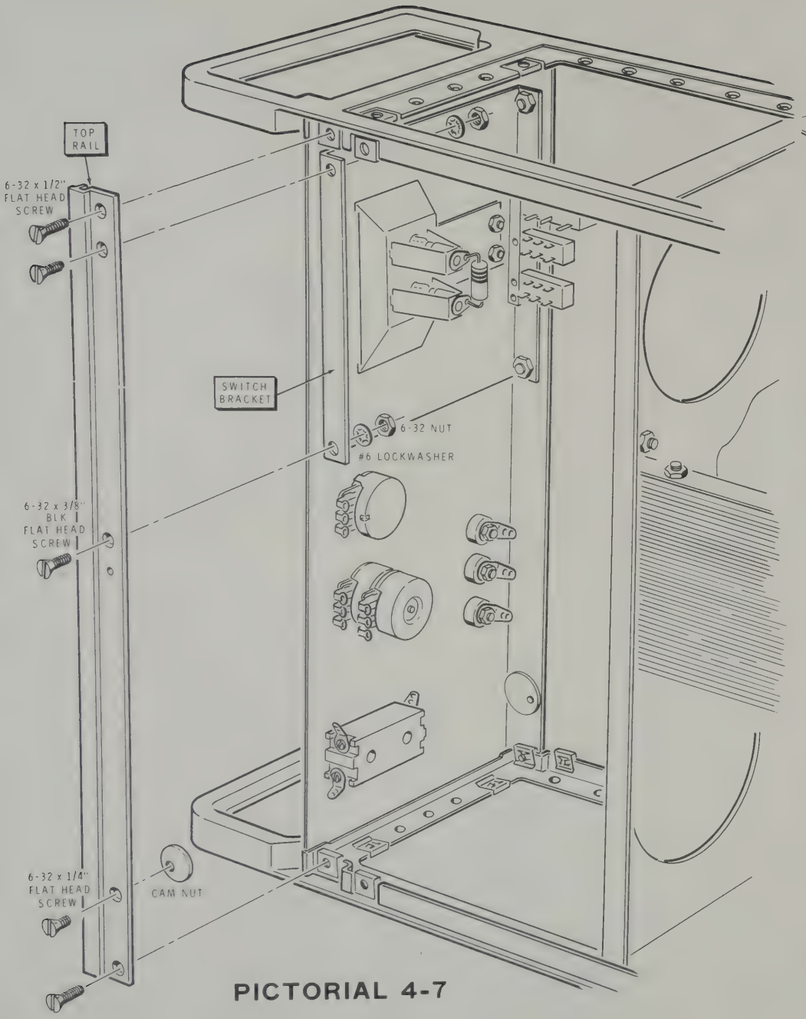
( ) Secure the switch bracket to the top rail with two 6-32 x 3/8" black flat head screws, #6 lockwashers, and 6-32 nuts.

( ) Loosely mount the other cam nut to the top rail with a 6-32 x 1/4" flat head screw.

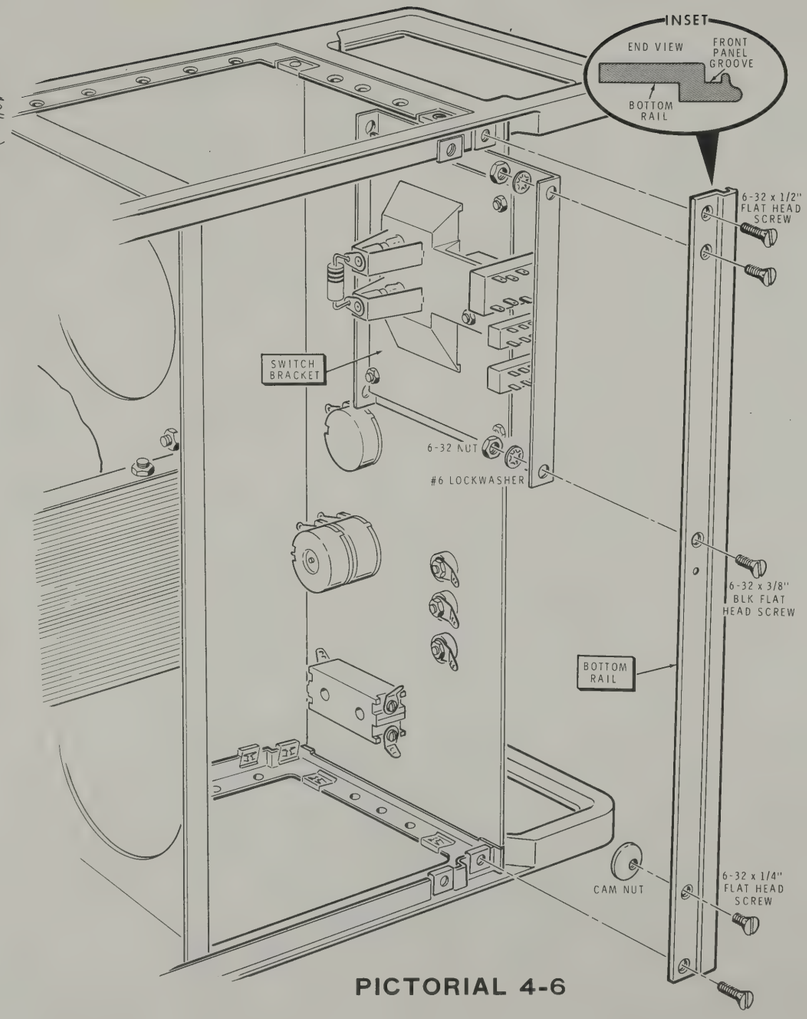
( ) Rotate the two cam nuts clockwise until they are pressed tightly against the front panel. Then tighten each screw.

( ) Tighten the four meter mounting nuts that secure the meter to the meter bracket.

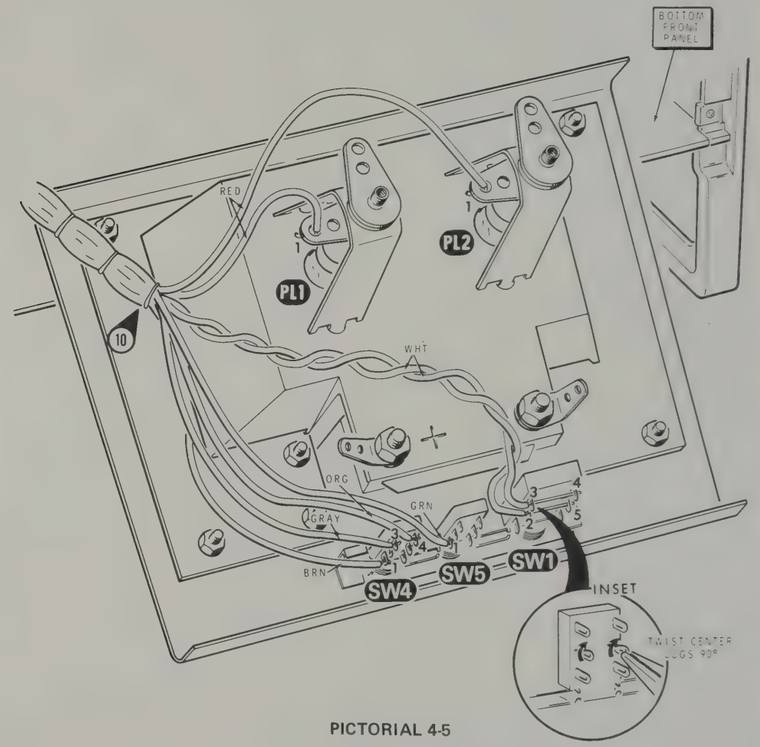




PICTORIAL 4-7



PICTORIAL 4-6



PICTORIAL 4-5

Refer to Pictorial 4-5 for the following steps.

Position the meter and switch assembly near the front panel and connect the wires from breakout #10 as follows:

( ) Either red wire to lamp socket PL2 lug 1 (S-1).

( ) Other red wire to lamp socket PL1 lug 1 (S-1).

( ) Remove an extra 3/8" of insulation from each wire of the white twisted pair. Then flatten the exposed wire so it will fit into the switch lugs.

( ) Refer to the inset drawing and twist the two center lugs (2 and 5) of switch SW1 90° so the lug holes are aligned.

Connect the remaining wires of breakout #10 as follows:

( ) Connect either white wire through switch SW1 lug 2 (S-2) to lug 5 (S-1).

( ) Connect the other white wire through switch SW1 lug 3 (S-2) to lug 4 (S-1).

( ) Connect the green wire to switch SW5 lug 1 (S-2). NOTE: Make sure the resistor has a good solder connection.

( ) Connect the orange wire to switch SW4 lug 4 (S-1).

( ) Connect the gray wire to switch SW4 lug 3 (S-1).

( ) Connect the brown wire to switch SW4 lug 1 (S-1).

Refer to Pictorial 4-6 (fold-out from Page 48) for the following steps.

( ) Refer to the inset drawing and locate the bottom rail.

( ) Position the bottom rail as shown and mount it to the handles with two 6-32 x 1/2" flat head screws. Be sure the front panel is seated in the groove.

( ) Position the meter and switch assembly behind the front panel (the meter must fit into the front panel cutout) and secure the switch bracket to the bottom rail with two 6-32 x 3/8" black flat head screws, #6 lockwashers, and 6-32 nuts. Check the switch buttons to see that they are centered in the panel opening. Shift the bracket if necessary.

( ) Loosely mount a cam nut to the bottom rail with a 6-32 x 1/4" flat head screw.

Refer to Pictorial 4-7 for the following steps.

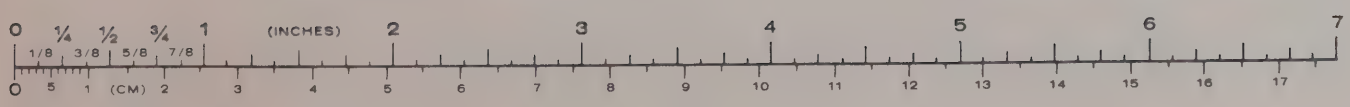
( ) Position the top rail as shown and mount it to the two handles with two 6-32 x 1/2" flat head screws.

( ) Secure the switch bracket to the top rail with two 6-32 x 3/8" black flat head screws, #6 lockwashers, and 6-32 nuts.

( ) Loosely mount the other cam nut to the top rail with a 6-32 x 1/4" flat head screw.

( ) Rotate the two cam nuts clockwise until they are pressed tightly against the front panel. Then tighten each screw.

( ) Tighten the four meter mounting nuts that secure the meter to the meter bracket.



Connect the remaining wires from breakout #6 to the circuit board as follows:

( ) Large black wire to hole 9 (S-1).

( ) Yellow wire to hole 10 (S-1).

( ) Gray wire to hole 11 (S-1).

( ) Blue wire to hole 12 (S-1).

Connect the wires coming from breakout #7 to the circuit board as follows:

( ) Large orange to hole 13 (S-1).

( ) Red wire to hole 14 (S-1).

( ) Violet wire to hole 15 (S-1).

( ) Green wire to hole 16 (S-1).

( ) Brown wire to hole 17 (S-1).

( ) Either yellow wire to hole 18 (S-1).

( ) Other yellow wire to hole 19 (S-1).

( ) Either orange wire to hole 20 (S-1).

( ) Other orange wire to hole 21 (S-1).

( ) White wire to hole 22 (S-1).

( ) Blue wire to hole 23 (S-1).

Refer to Pictorial 4-9 (fold-out from Page 50) for the following steps.

( ) Rotate the circuit board into the chassis and press it onto the four circuit board supports until it snaps into position.

( ) Carefully position the wire harness straight out from the circuit board. This will allow easier access to the circuit board controls.

NOTE: To remove the circuit board, gently squeeze the small tab on each support and pull out on the circuit board as shown in the inset drawing.

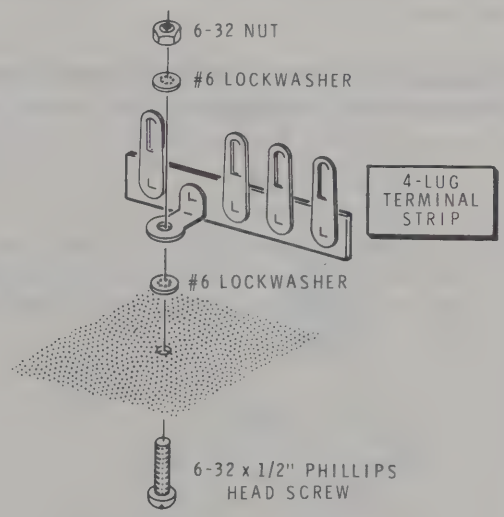
Temporarily set the chassis aside.

HEAT SINK ASSEMBLY

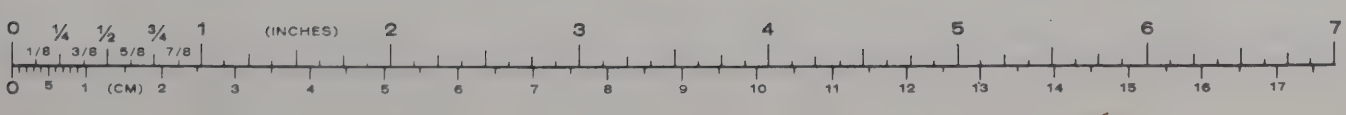
Refer to Pictorial 5-1 (fold-out from Page 50) for the following steps.

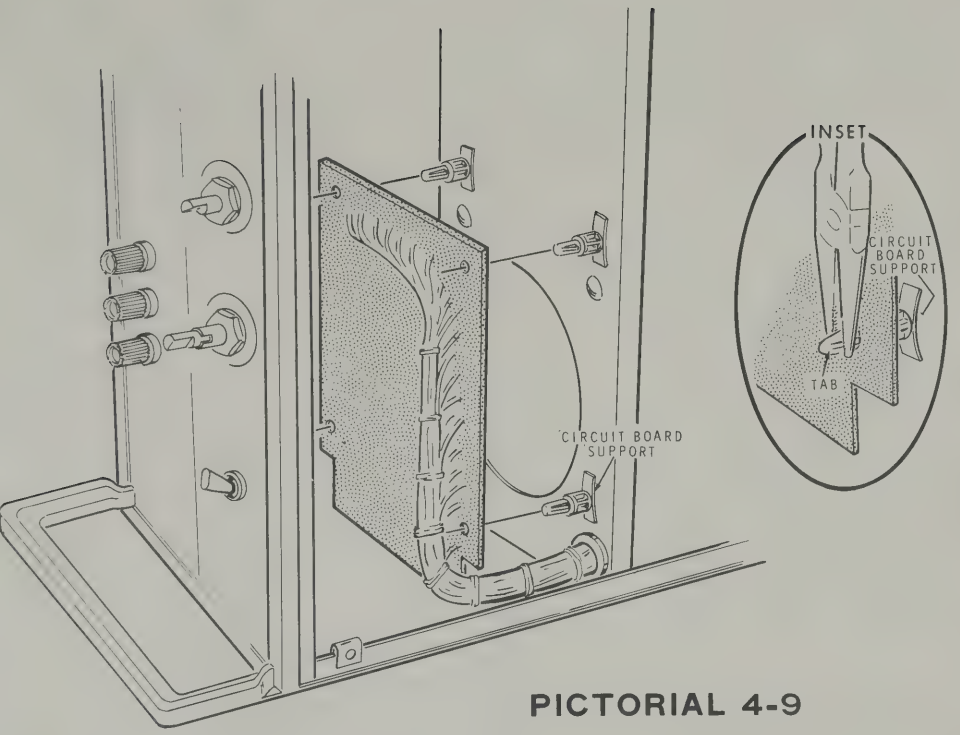
( ) Position the heat sink as shown.

( ) Refer to Detail 5-1A and mount a 4-lug terminal strip (#431-79) at EC with a 6-32 x 1/2" phillips screw, two #6 lockwashers, and a 6-32 nut.

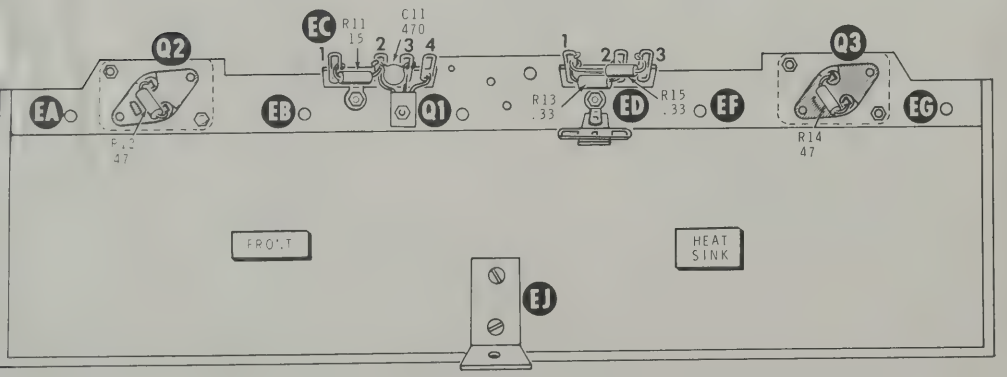


Detail 5-1A

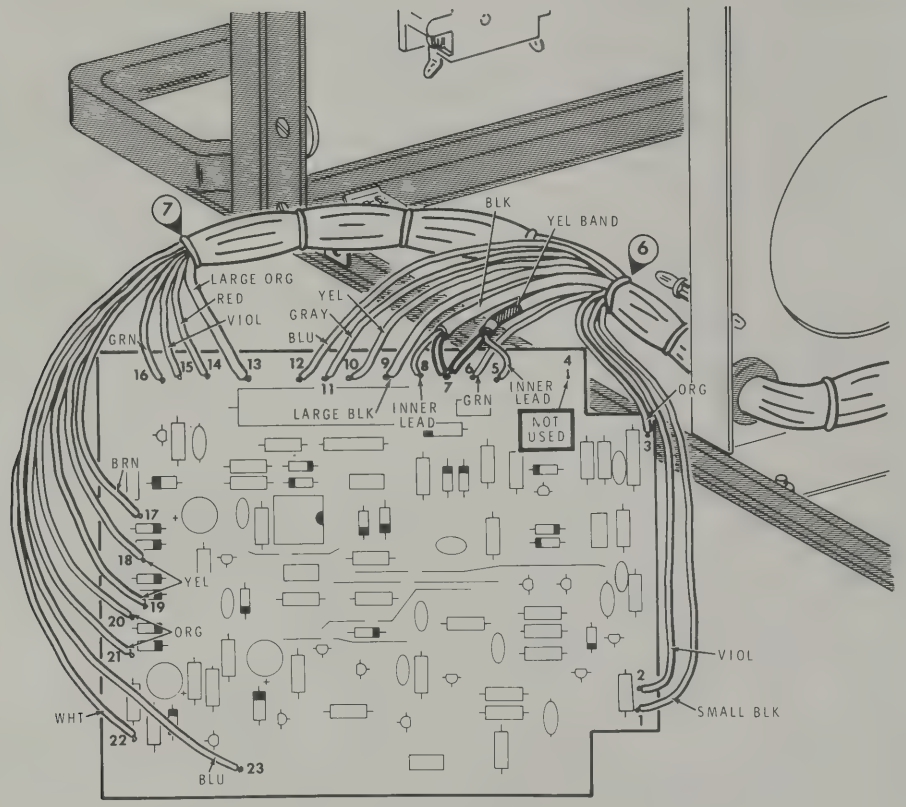




PICTORIAL 4-9



PICTORIAL 5-1



PICTORIAL 4-8

CIRCUIT BOARD INSTALLATION

Refer to Pictorial 4-8 for the following steps.

( ) Position the chassis as shown.

NOTE: After you solder a wire to the board, cut off any excess wire length.

Connect the wires coming from breakout #6 to the component side of the circuit board as follows:

( ) Small black wire to hole 1 (S-1).

( ) Violet wire to hole 2 (S-1).

( ) Orange wire to hole 3 (S-1).

( ) Inner lead of yellow-banded shielded cable to hole 5 (S-1). NOTE: No wire is connected to hole 4.

( ) Connect the green wire to hole 6 (S-1).

( ) Connect the inner lead of the black shielded cable to hole 8 (S-1).

( ) Cut a 3/4" length of sleeving and place it over the shield lead of the yellow-banded shielded cable. Then insert the shield lead into hole 7 (NS).

( ) Cut a 5/8" length of sleeving and place it over the shield lead of the black shielded cable. Then insert the shield lead into hole 7 (S-2).

Connect the remaining wires from breakout #6 to the circuit board as follows:

( ) Large black wire to hole 9 (S-1).

( ) Yellow wire to hole 10 (S-1).

( ) Gray wire to hole 11 (S-1).

( ) Blue wire to hole 12 (S-1).

Connect the wires coming from breakout #7 to the circuit board as follows:

( ) Large orange to hole 13 (S-1).

( ) Red wire to hole 14 (S-1).

( ) Violet wire to hole 15 (S-1).

( ) Green wire to hole 16 (S-1).

( ) Brown wire to hole 17 (S-1).

( ) Either yellow wire to hole 18 (S-1).

( ) Other yellow wire to hole 19 (S-1).

( ) Either orange wire to hole 20 (S-1).

( ) Other orange wire to hole 21 (S-1).

( ) White wire to hole 22 (S-1).

( ) Blue wire to hole 23 (S-1).

Refer to Pictorial 4-9 (fold-out from Page 50) for the following steps.

( ) Rotate the circuit board into the chassis and press it onto the four circuit board supports until it snaps into position.

( ) Carefully position the wire harness straight out from the circuit board. This will allow easier access to the circuit board controls.

NOTE: To remove the circuit board, gently squeeze the small tab on each support and pull out on the circuit board as shown in the inset drawing.

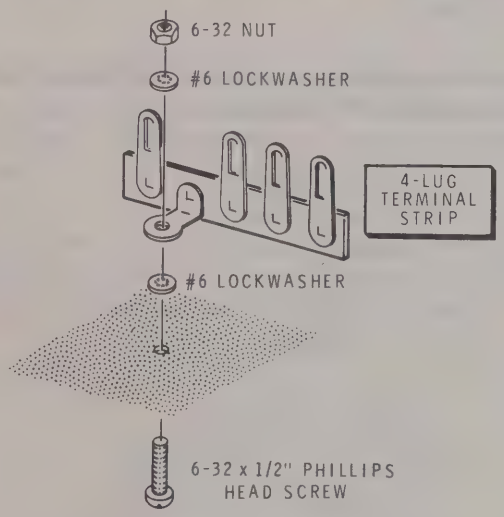
Temporarily set the chassis aside.

HEAT SINK ASSEMBLY

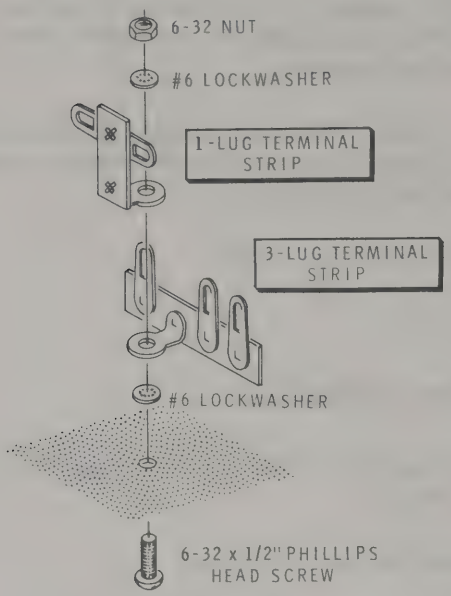
Refer to Pictorial 5-1 (fold-out from Page 50) for the following steps.

( ) Position the heat sink as shown.

( ) Refer to Detail 5-1A and mount a 4-lug terminal strip (#431-79) at EC with a 6-32 x 1/2" phillips screw, two #6 lockwashers, and a 6-32 nut.



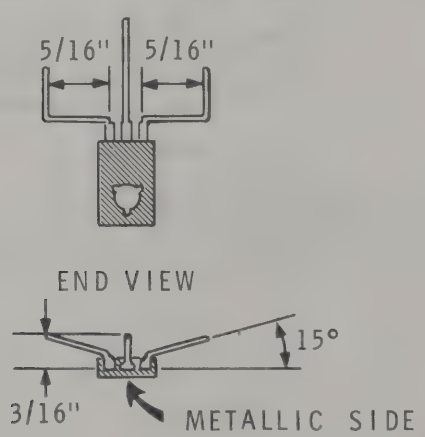
Detail 5-1A



Detail 5-1B

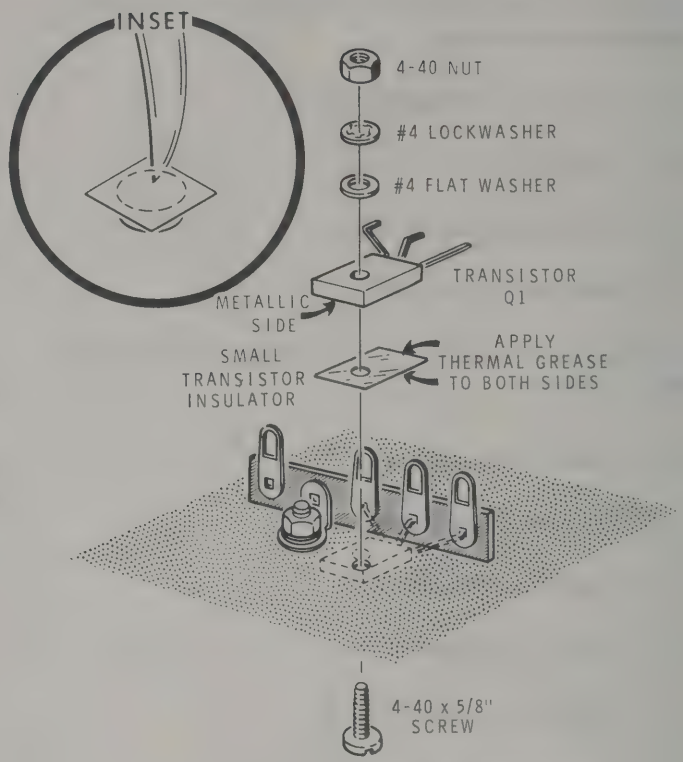
( ) Refer to Detail 5-1B and mount a 3-lug (#431-3) and a 1-lug (#431-1) terminal strip at ED with a 6-32 x 1/2" phillips head screw, two #6 lockwashers, and a 6-32 nut.

( ) Refer to Detail 5-1C and form the leads of a SJE608 transistor (#417-264) as shown.



Detail 5-1C

WARNING: You will be using Dow Corning 340 thermal heat sink compound in the next step and several other steps in the Manual. Although the compound is not caustic, it may cause temporary discomfort if it gets into your eyes. Should this happen, rinse your eyes with warm water. If the compound gets into your clothing, the clothing may require professional cleaning. The compound contains Zinc Oxides, SiO_2, and sligh traces of CO_2.



Detail 5-1D

( ) Refer to the inset drawing in Detail 5-1D, cut open the thermal grease cup, and mix this grease to a smooth consistency.

( ) Q1: Refer to Detail 5-1D and mount a SJE608 transistor (#417-264) to the heat sink as follows:

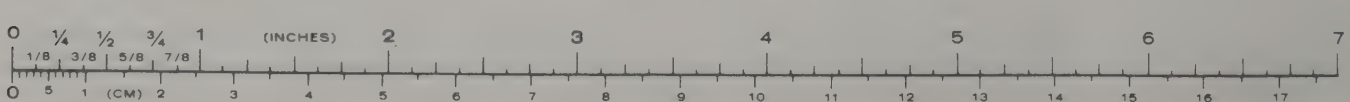
1. Apply a thin layer of thermal grease to each side of the small transistor insulator. NOTE: The remaining portion of grease will be used when you install the three power transistors.

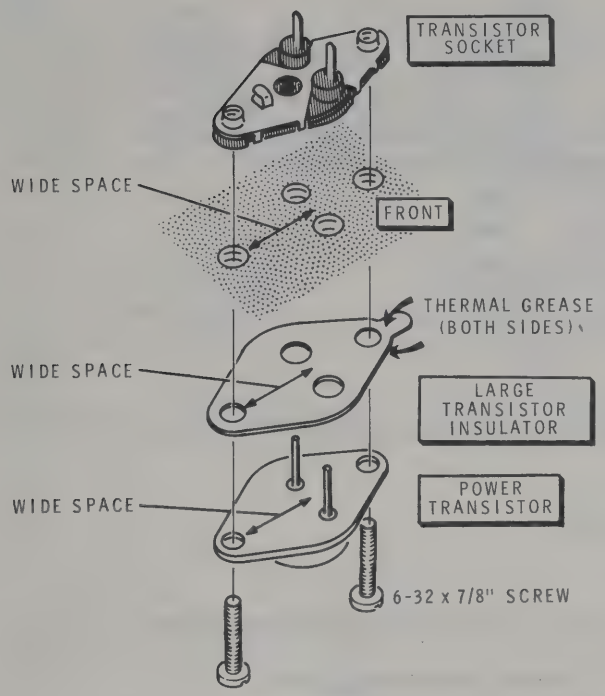
2. Position the plastic transistor insulator on the heat sink at hole Q1.

3. Insert the three leads of transistor Q1 into the lower eyelets on terminal strip EC and lay the transistor body (metallic side down) onto the plastic transistor insulator.

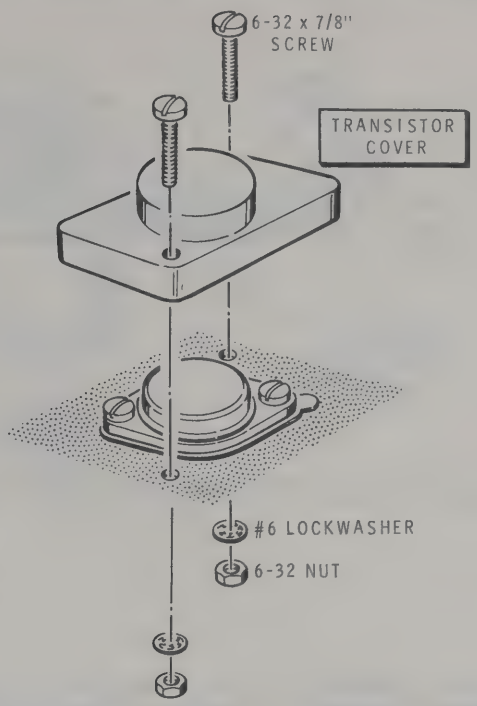
4. Secure the transistor with a 4-40 x 5/8" screw, #4 flat washer, #4 lockwasher, and 4-40 nut.

( ) Solder the leads of the transistor to the eyelet holes in terminal strip EC. Cut off any excess lead lengths.





Detail 5-1E



Detail 5-1F

( ) Refer to Detail 5-1E and apply a thin layer of thermal grease to both sides of a large transistor insulator.

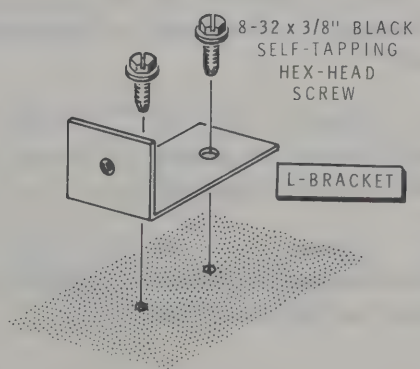
( ) Q2: Refer to Detail 5-1E and mount a 2N6306 transistor (#417-833) at Q2 as follows.

1. Position the insulator on the back side of the heat sink at Q2. Note the wide spacing between holes.
2. Lay a 2N6306 power transistor (#417-833) on the insulator.
3. Press a transistor socket onto the leads of the power transistor. Make sure the socket lies flush with the heat sink and the ridges on the socket fit into the heat sink holes.
4. Secure the power transistor with two 6-32 x 7/8" screws.
5. Wipe off the excess grease.

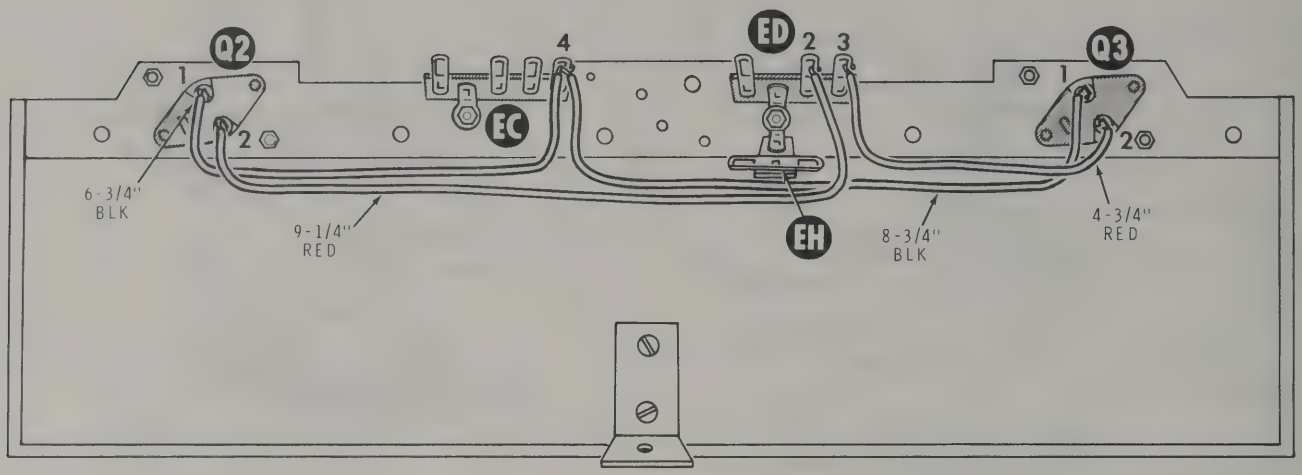
( ) Q3: In like manner, mount a 2N6306 power transistor (#417-833) at Q3. NOTE: The heat sink was designed to accommodate three power transistors. The center mounting location is not used on this instrument.

( ) Refer to Detail 5-1F and mount transistor covers over the power transistors at Q2 and Q3. Use two 6-32 x 7/8" screws, #6 lockwashers, and 6-32 nuts for each cover.

( ) Locate two 8-32 x 3/8" black hex-head, self-tapping screws. Then refer to Detail 5-1G and mount the L-bracket to the heat sink at EJ with the screws.



Detail 5-1G



PICTORIAL 5-2

( ) R12: Connect a 47 Ω, 10%, 1/2-watt (yellow-violet-black) resistor to transistor socket Q2 between lugs 1 (NS) and 2 (NS).

( ) R14: Connect a 47 Ω, 10%, 1/2-watt (yellow-violet-black) resistor to transistor socket Q3 between lugs 1 (NS) and 2 (NS).

( ) R11: Connect a 15 Ω, 5%, 1/2-watt (brown-green-black) resistor to terminal strip EC between lugs 1 (NS) and 2 (NS).

( ) C11: Connect a 470 pF ceramic capacitor to terminal strip EC between lugs 2 (S-2) and 3 (NS).

In the following steps, when you install the next two resistors to the lugs of terminal strip ED be sure to position them as shown so the leads will not short circuit the terminal strip.

( ) R13: Connect a .33 Ω, 5%, 2-watt (orange-orange-silver) resistor to terminal strip ED between lugs 1 (NS) and 2 (NS).

( ) R14: Connect a .33 Ω, 5%, 2-watt (orange-orange-silver) resistor to terminal strip ED between lugs 1 (NS) and 3 (NS).

Refer to Pictorial 5-2 for the following steps.

( ) Prepare the following wires:

6-3/4" black solid
8-3/4" black solid
9-1/4" small red stranded
4-3/4" small red stranded

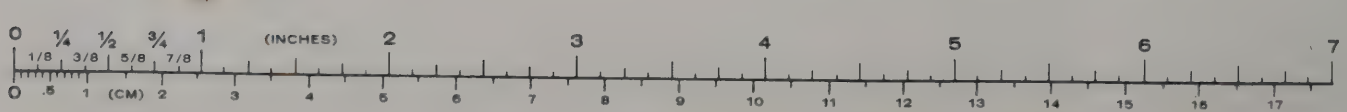
NOTE: Position the wires as shown in the Pictorial.

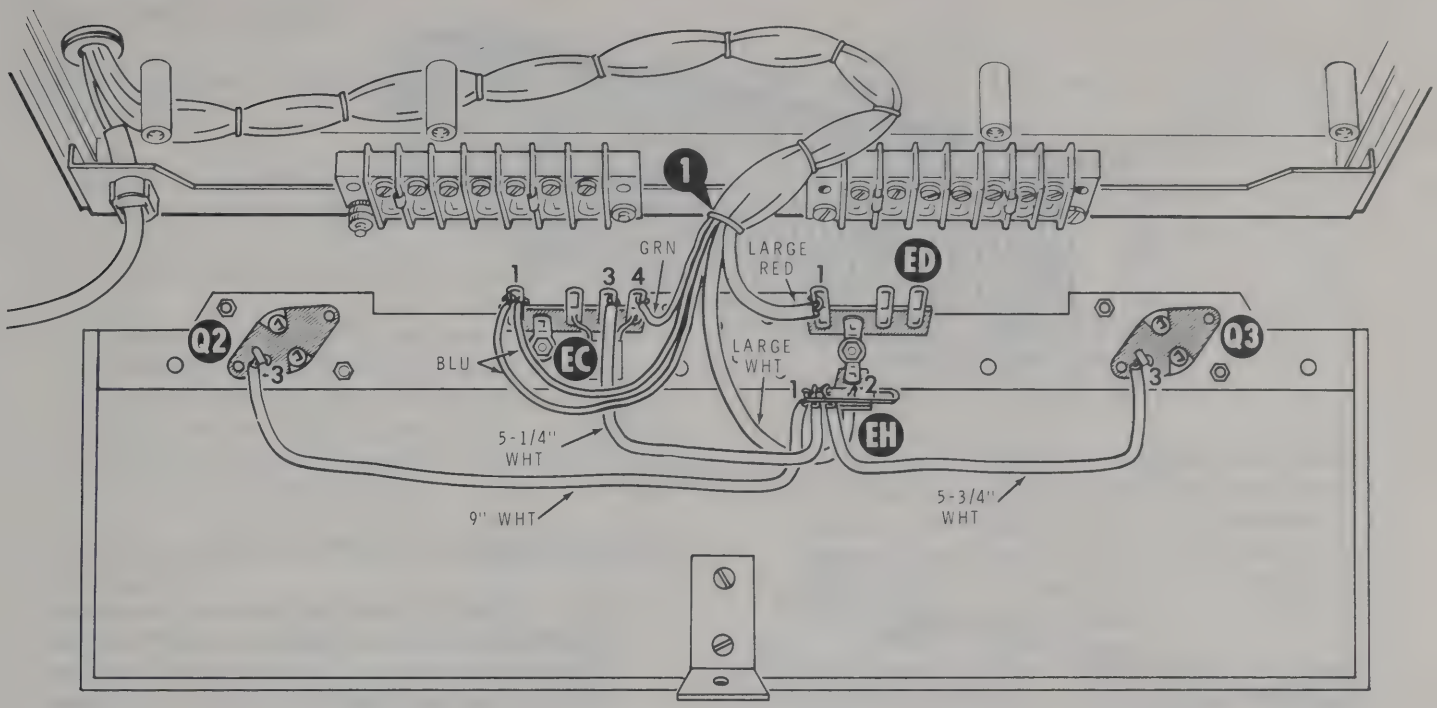
( ) Connect a 6-3/4" black wire from socket Q2 lug 1 (S-2) to terminal strip EC lug 4 (NS).

( ) Connect an 8-1/4" black wire from socket Q3 lug 1 (S-2) to terminal strip EC lug 4 (NS).

( ) Connect a 9-1/4" red stranded wire from socket Q2 lug 2 (S-2) to terminal strip ED lug 2 (S-2).

( ) Connect a 4-3/4" red stranded wire from socket Q3 lug 2 (S-2) to terminal strip ED lug 3 (S-2).





PICTORIAL 5-3

Refer to Pictorial 5-3 for the following steps.

( ) Prepare the following small white stranded wires:

9"
5-3/4"
5-1/4"

NOTE: Position the wires as shown in the Pictorial.

( ) Connect a 9" white stranded wire from socket Q2 lug 3 (S-1) to terminal strip EH hole 1 (NS). Be careful not to burn the black wire near lug 3.

( ) Connect a 5-3/4" white stranded wire from socket Q3 lug 3 (S-1) to terminal strip EH hole 1 (NS). Be careful not to burn the black wire near lug 3.

( ) Connect a 5-1/4" white stranded wire from terminal strip EC lug 3 (S-2) to terminal strip EH hole 1 (S-3).

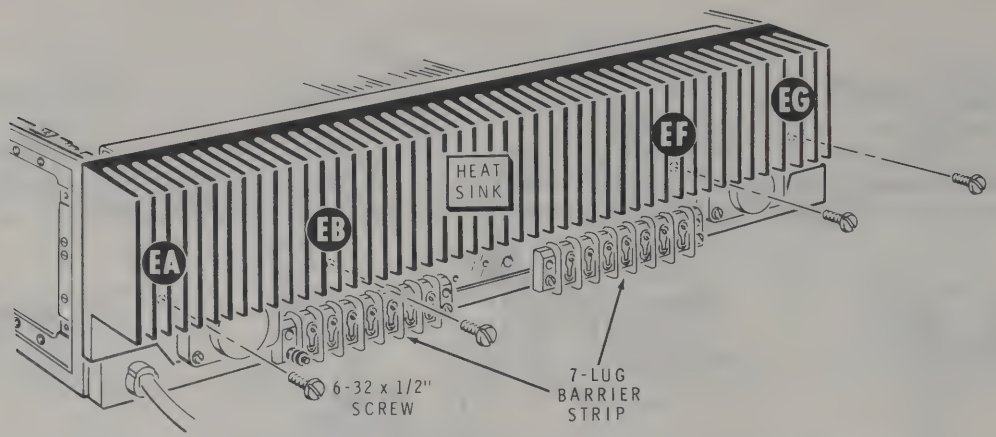
Position the heat sink near the rear panel of the Power Supply and connect the wires from breakout #1 as follows:

( ) Both blue wires to terminal strip EC lug 1 (S-3).

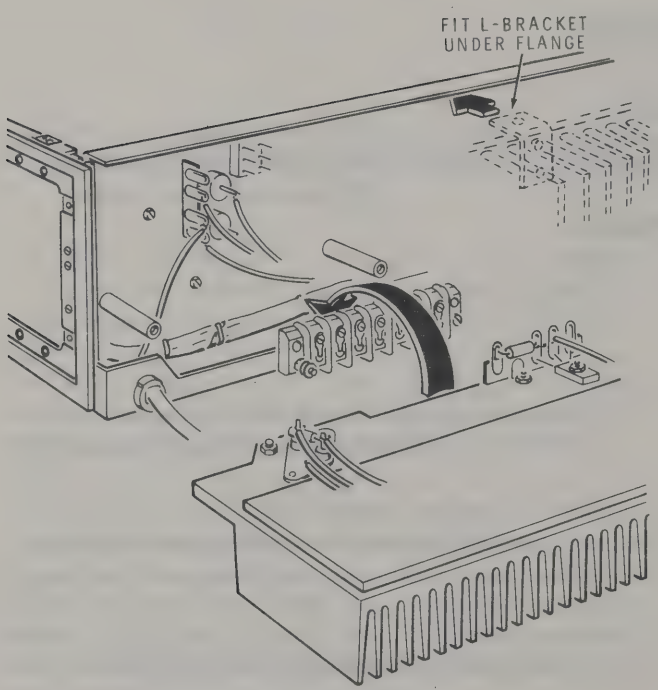
( ) Green wire to terminal strip EC lug 4 (S-3).

( ) Large red wire to terminal strip ED lug 1 (S-3)

( ) Large white wire to terminal strip EH hole 2 (S-1).



PICTORIAL 5-4



Detail 5-4A

Refer to Pictorial 5-4 for the following steps.

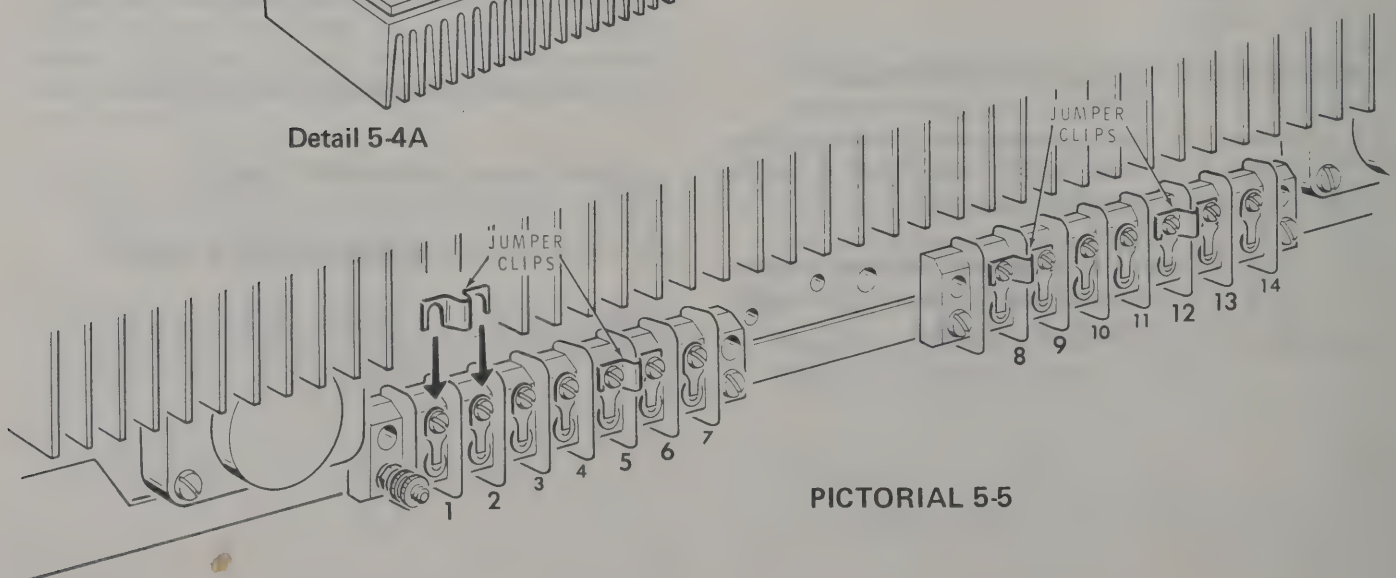
( ) Refer to Detail 5-4A and install the heat sink onto the rear panel behind the two barrier strips. NOTE: It may be necessary to force the L-bracket, on the heat sink, under the rear panel flange. Be careful not to break the terminal strips.

( ) Secure the heat sink to the rear panel with four 6-32 x 1/2" screws at holes EA, EB, EF, and EG.

Refer to Pictorial 5-5 for the following steps.

( ) Loosen barrier strip terminal screws 1, 2, 5, 6, 8, 9, 12, and 13.

( ) Slip jumper clips behind screws 1 and 2, 5 and 6, 8 and 9, and 12 and 13. Then tighten the eight screws.



PICTORIAL 5-5

KNOB INSTALLATION

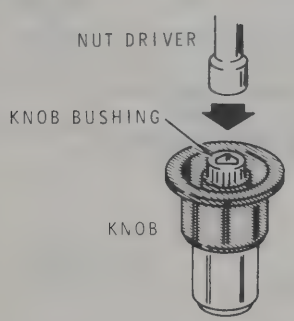
Refer to Pictorial 6-1 (fold-out from this page) for the following steps.

( ) Press the 1/4" knob bushing onto the CURRENT control shaft, large end first.

( ) Rotate the control fully counterclockwise.

( ) Lightly press the double knob onto the bushing so the pointer is positioned at the end of the rotation arrow. Then rotate the control fully clockwise. If necessary, reposition the knob on the bushing so the knob pointer is the same distance from each end of the arrow through its full rotation.

( ) Carefully pull the knob and knob bushing off together.

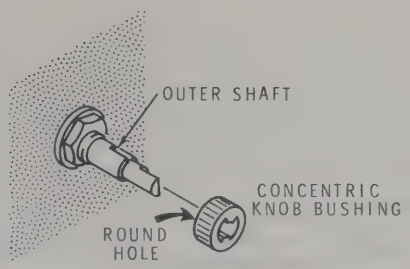


Detail 6-1A

( ) Refer to Detail 6-1A and drive the knob bushing into the knob as far at it will go with a nut driver, or a similar object.

( ) Reinstall the double knob on the CURRENT control shaft.

( ) Refer to Detail 6-1B and press the concentric knob bushing onto the outer shaft of the VOLTAGE control. Note that the end of the bushing that is completely round is positioned toward the front panel.



Detail 6-1B

( ) Rotate the control fully counterclockwise.

( ) Lightly press the large black knob onto the bushing so the pointer is positioned at the end of the rotation arrow. Rotate the control fully clockwise. If necessary, reposition the knob on the bushing so the knob pointer is the same distance from each end of the arrow through its full rotation.

( ) Remove the knob and bushing, and drive the bushing into the knob as far as it will go. Then reinstall the knob.

( ) Press the 3/16" knob bushing onto the small VOLTAGE control shaft, large end first.

( ) Rotate both VOLTAGE controls fully counterclockwise.

( ) Align the pointer of the small red knob to the pointer of the black knob, and press the red knob onto the bushing.

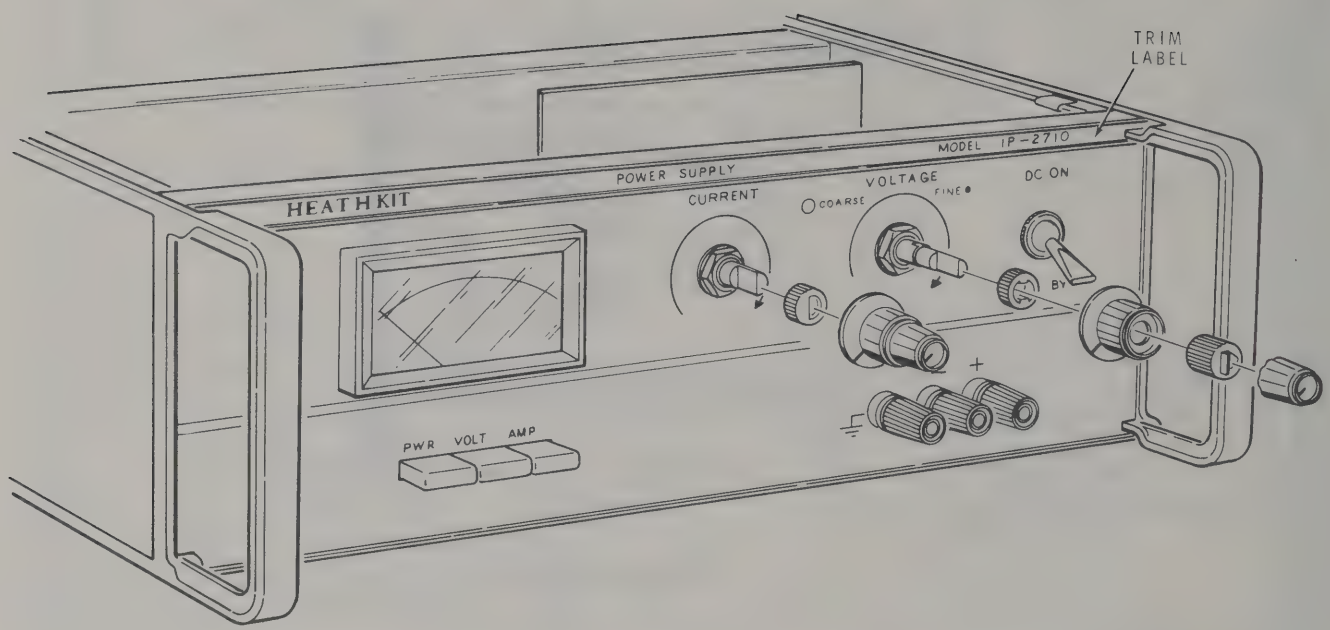
( ) Remove the knob and bushing, and drive the bushing into the knob.

( ) Reinstall the small red knob onto the shaft.

( ) Remove the backing paper from the trim label, carefully position the label inside the groove in the top rail, and press the label onto the rail.

This completes the "Step-by-Step Assembly." Proceed to "Initial Checkout."

NOTE: There is a 150 Ω, 1/2-watt resistor left over. This will be used for calibration.



PICTORIAL 6-1

INITIAL CHECKOUT

Check out the Power Supply for any assembly errors by carefully performing the following checks. You will first perform a visual check, and then turn the power on and observe the various operational characteristics.

VISUAL CHECK

1. Carefully check the wiring of the two filter capacitors, C2 and C3. Make sure there are no solder splashes or wire ends causing a short circuit.

2. Make sure none of the solder lugs on capacitors C2 and C3 touch adjacent terminal solder lugs.

3. Check the rear panel terminal strips for wire or solder short circuits.

4. Make sure none of the circuit board wires are shorted to each other, adjacent components, or the chassis.

5. Check the front panel meter switch wires and control wires for short circuits.

6. Make sure the 120/240 switch is in the correct position.

OPERATIONAL CHECK

WARNING: When the line cord is connected to an AC outlet, high AC voltage is present at several places on the chassis. See Figure 1-1. Also, when the Power Supply is turned on, high voltage DC will also be present. Be careful that you do not contact these high voltage areas or an electrical shock will result.

If any problems occur during this check, turn the PWR switch off immediately and refer to the "In Case of Difficulty" section Page 73.

1. Position the controls and switches as follows:

   Circuit board controls (See Figure 1-2) – Center of rotation.

   VOLTAGE controls (See Figure 3-1 on fold-out from Page 71) – Fully counterclockwise.

   CURRENT control – Fully counterclockwise.

   DC ON/STANDBY switch – STANDBY (down).

   PWR switch – Out.

   AMP switch – In.

   VOLT switch – Out.

2. Connect the line cord plug to a suitable power source.

3. Carefully observe the Power Supply circuits and press the PWR switch. If the meter pointer moves more than halfway upscale, switch the power off immediately.

4. Press the VOLT switch and turn the CURRENT control to the center of its rotation.

5. Turn the COARSE VOLTAGE control clockwise. The meter pointer should move up-scale.

6. Return all the controls and switches to their original positions, and disconnect the line cord plug.

7. Proceed to "Final Assembly".

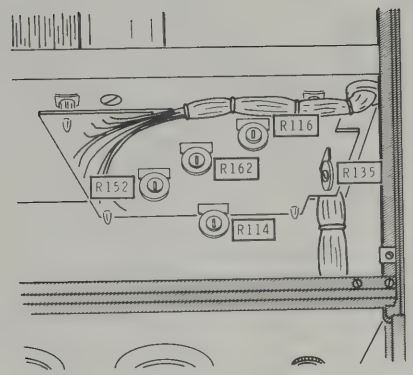


Figure 2-1

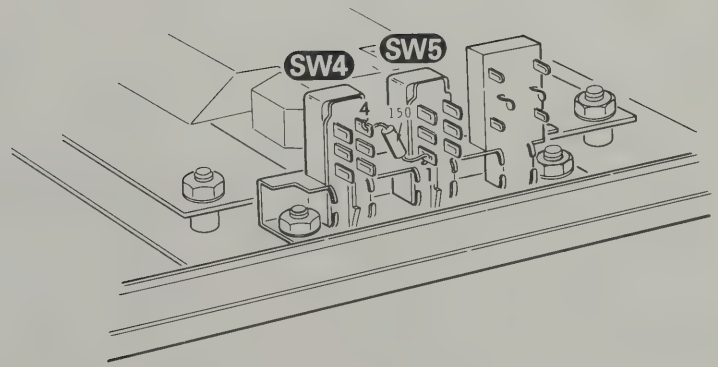


Figure 2-2

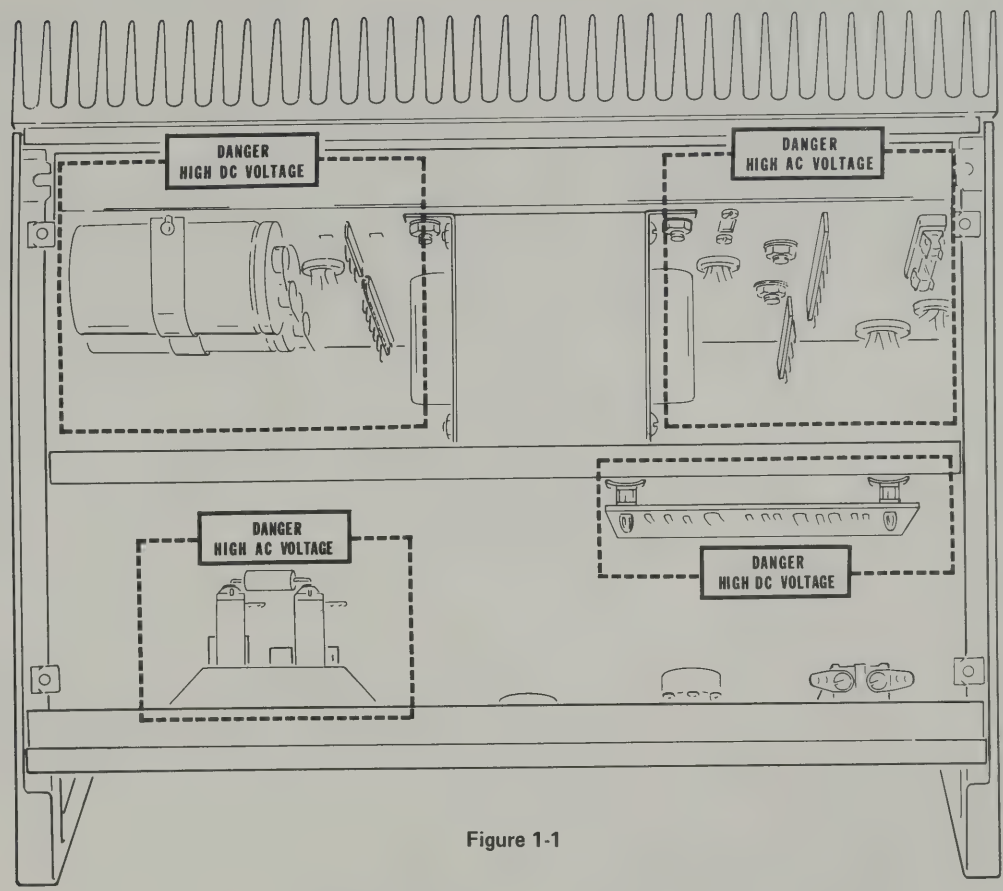


Figure 1-1

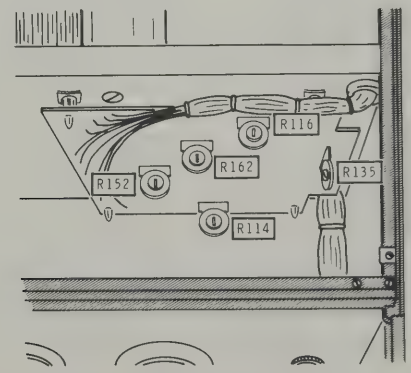


Figure 1-2

INITIAL CHECKOUT

Check out the Power Supply for any assembly errors by carefully performing the following checks. You will first perform a visual check, and then turn the power on and observe the various operational characteristics.

VISUAL CHECK

1. Carefully check the wiring of the two filter capacitors, C2 and C3. Make sure there are no solder splashes or wire ends causing a short circuit.

2. Make sure none of the solder lugs on capacitors C2 and C3 touch adjacent terminal solder lugs.

3. Check the rear panel terminal strips for wire or solder short circuits.

4. Make sure none of the circuit board wires are shorted to each other, adjacent components, or the chassis.

5. Check the front panel meter switch wires and control wires for short circuits.

6. Make sure the 120/240 switch is in the correct position.

OPERATIONAL CHECK

WARNING: When the line cord is connected to an AC outlet, high AC voltage is present at several places on the chassis. See Figure 1-1. Also, when the Power Supply is turned on, high voltage DC will also be present. Be careful that you do not contact these high voltage areas or an electrical shock will result.

If any problems occur during this check, turn the PWR switch off immediately and refer to the "In Case of Difficulty" section Page 73.

1. Position the controls and switches as follows:

   Circuit board controls (See Figure 1-2) – Center of rotation.

   VOLTAGE controls (See Figure 3-1 on fold-out from Page 71) – Fully counterclockwise.

   CURRENT control – Fully counterclockwise.

   DC ON/STANDBY switch – STANDBY (down).

   PWR switch – Out.

   AMP switch – In.

   VOLT switch – Out.

2. Connect the line cord plug to a suitable power source.

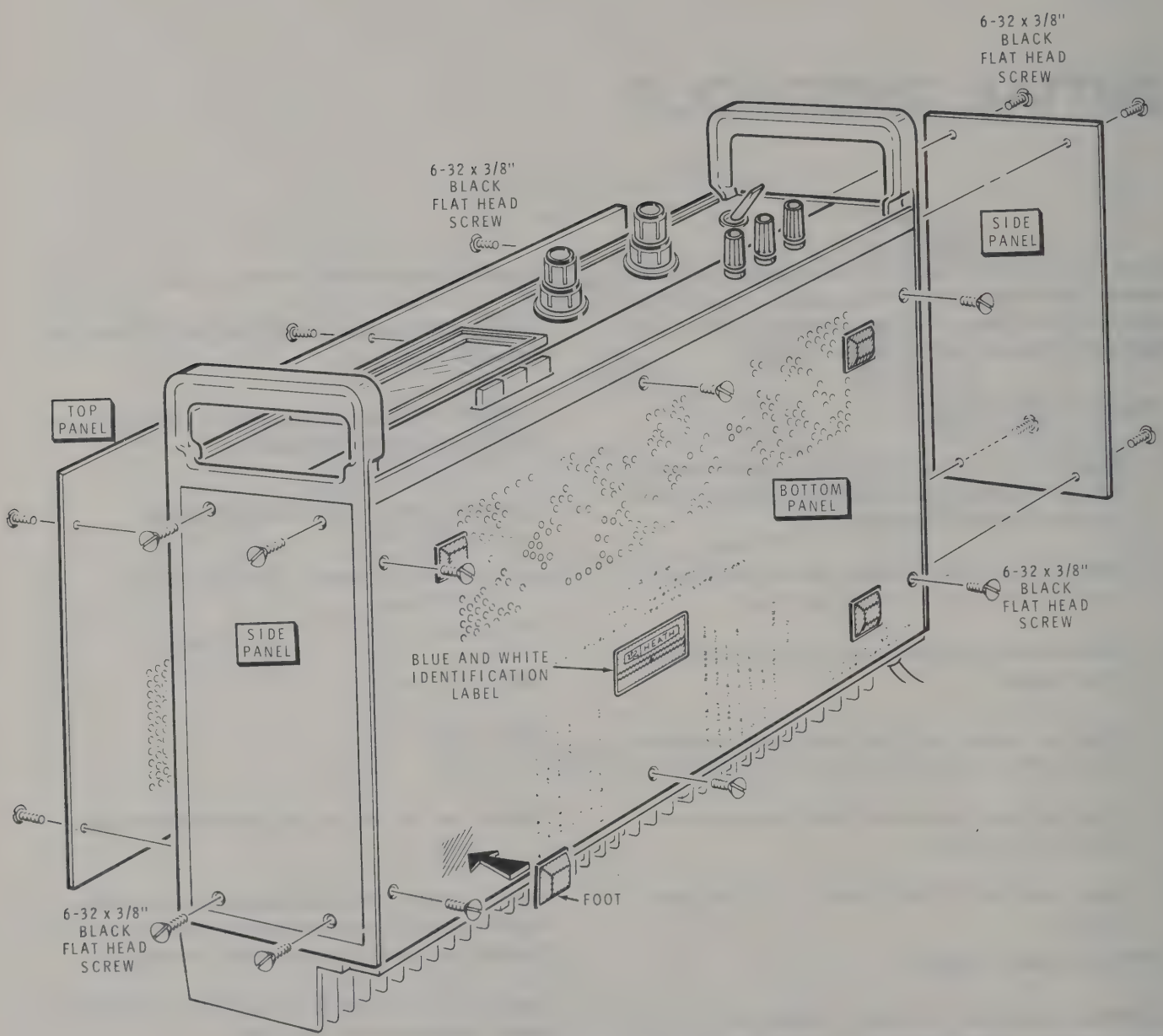
3. Carefully observe the Power Supply circuits and press the PWR switch. If the meter pointer moves more than halfway upscale, switch the power off immediately.

4. Press the VOLT switch and turn the CURRENT control to the center of its rotation.

5. Turn the COARSE VOLTAGE control clockwise. The meter pointer should move up-scale.

6. Return all the controls and switches to their original positions, and disconnect the line cord plug.

7. Proceed to "Final Assembly".



PICTORIAL 7-1

FINAL ASSEMBLY

Refer to Pictorial 7-1 for the following steps.

NOTE: It may be necessary to align some of the push-on nuts before you can start the screws into them.

( ) Place the bottom panel (panel with printing on it) on a flat surface.

( ) Remove the backing paper from a foot and press the foot onto the bottom panel in one of the square location outlines.

( ) In like manner, mount the three remaining feet.

( ) Remove the backing paper from the blue and white identification label and press the label onto the bottom panel in the location shown.

NOTE: The blue and white label shows the Model number and Production Series number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

NOTE: You will install the four panels in the following steps so that the Power Supply can warm up before calibration. All of the screws illustrated will not be used at this time. However, you should use all of the screws after calibration.

( ) Mount the bottom panel to the bottom of the chassis with six 6-32 x 3/8" black flat head screws. Note that the vent holes are located at the front of the chassis.

( ) Mount the top panel to the top of the chassis with two 6-32 x 3/8" black flat head screws. Note that the vent holes are located at the rear of the chassis.

( ) Examine the circuit board wires, to see if any are short circuited to each other, to adjacent components, or to the top panel.

( ) Mount the left side panels with four 6-32 x 3/8" black flat head screws.

( ) Mount the right side panel with two 6-32 x 3/8" black flat head screws.

This completes the "Final Assembly." Proceed to the "Calibration" section.

CALIBRATION

Calibration is easily performed with the 150 ohm resistor supplied with this instrument. If you do not get the proper response to any of these steps, refer to the "In Case of Difficulty" section (Page 73), or to the inside rear cover of this Manual for information on technical assistance. Figures 2-1 and 2-2 (fold-out from Page 58) show the location of the adjustments and test point.

1. Preset the controls and switches as follows:

   PWR switch – Off (out).

   VOLT switch – On (in).

   AMP switch – Off (out).

   DC ON/STANDBY switch – STANDBY (down).

   CURRENT control – Fully counterclockwise.

   VOLTAGE control:

      COARSE – Fully counterclockwise.

      FINE – Fully counterclockwise.

2. Check the two rear-panel barrier terminal strips to insure that the jumpers are installed for "normal" operation. There should be jumpers between terminals 1 and 2, 5 and 6, 8 and 9, and 12 and 13. Do not attempt to calibrate the Power Supply in a "program" mode.

3. Insert the line cord plug into the proper power outlet and press the PWR switch. The meter should light.

4. Allow the Power Supply 30 minutes to warm up before you begin calibration.

5. Remove the screws from the top cover and remove the top cover.

6. Remove the screws that secure the right side panel and remove the panel.

7. Turn the front panel CURRENT control to the center of its rotation.

8. Adjust the front panel COARSE and FINE VOLTAGE controls until the meter indicates 5 volts.

NOTE: Look directly into the meter for an accurate reading. If you view the meter from an angle, optical parallax will produce an inaccurate reading.

9. Connect the 150 ohm resistor between the + and – binding posts on the front panel.

10. Turn the front panel CURRENT control fully counterclockwise. The meter reading may decrease.

11. Set the DC ON/STANDBY switch to DC ON.

12. Adjust R152, the Zero Current control, for a 2-volt meter indication.

13. Set the DC ON/STANDBY switch to STANDBY. The meter will again read 5 volts.

14. Remove the 150 ohm resistor and short the + and – binding posts together with a wire.

15. Press the AMP switch.

16. Set the DC ON/STANDBY switch to DC ON.

17. Slowly turn the front panel CURRENT control clockwise; and R162, the Maximum Current control, counterclockwise (viewed from top); until the front panel CURRENT control is fully clockwise and the meter indicates 3 amperes. CAUTION: Do not let the supply exceed 3 amperes.

18. Set the DC ON/STANDBY switch to STANDBY.

19. Remove the wire short from between the + and – binding posts.

20. Switch the Power Supply off and disconnect the line cord plug.

21. Turn the Power Supply over, remove the screws from the bottom cover, and remove the cover.

22. Refer to Figure 2-2 (fold-out from Page 58) and temporarily solder the 150 ohm resistor between switch SW5 lug 1 (green wire) and switch SW4 lug 4 (orange wire). Make sure the resistor leads do not touch any other switch lugs or the chassis.

23. Turn the front panel CURRENT control to its center of rotation.

24. Turn the front panel COARSE and FINE VOLTAGE voltage controls fully counterclockwise.

25. Press the VOLT switch.

26. Reconnect the line cord plug and press the PWR switch (power on).

27. Rotate R135, the Zero Voltage control, clockwise (viewed from side) until the meter needle begins to move up-scale. Then rotate the control counterclockwise until the meter needle just indicates zero. You may wish to repeat this adjustment several times to insure an accurate zero.

28. Switch the Power Supply off and disconnect the line cord plug.

29. Carefully unsolder the 150 ohm resistor and examine the switch assembly for any loose solder connections or solder bridges. NOTE: Save the resistor in case you wish to calibrate this instrument at some future date.

30. Install the bottom cover and the side cover.

31. Reconnect the line cord plug and press the PWR switch.

32. Turn the COARSE and FINE VOLTAGE controls fully clockwise.

33. Adjust R116, the Maximum Voltage control, for a meter indication of exactly 30 volts.

34. Turn the COARSE and FINE VOLTAGE controls and CURRENT control fully counterclockwise.

35. Switch the POWER Supply off and disconnect the line cord plug.

NOTE: If you plan on using your Power Supply in the resistance programming mode, refer to "Example #4" on Page 68 of this Manual.

36. Reinstall the top cover.

This completes the "Calibration." Proceed to the "Operation" section.

OPERATION

This section of the Manual explains the function of each control, switch, and connector; describes several operational examples; and provides a load wire rating chart.

CONTROL FUNCTIONS

The Power Supply has two basic modes of operation: constant voltage and constant current, which function independently of each other. The voltage level is controlled by the front panel VOLTAGE control or the program input (see below) as long as the load draws less than the preset current level. If the load current should increase above the level set by the front panel CURRENT control or program input, the Power Supply will limit the load current.

Power Supply operation is controlled by:

A. The front panel controls, switches, and connectors, which are described on Figure 3-1 on the fold-out from Page 71.

B. The connections made to the programming terminals (the two 7-lug barrier strips) on the rear panel. The function of each terminal is described in Figure 3-2 (fold-out from Page 71).

You can use the programming terminals on the rear panel to operate, or program, this Power Supply in any of the following ways. Each of these types of operation will be explained in greater detail in the "Operational Examples."

Local Sensing – In this type of operation, the voltage to be regulated is sensed directly at the front panel output binding posts or from the rear panel output terminals.

Remote Sensing – Error voltages are taken at the terminals of the load itself, and then coupled back to the sensing terminals on the rear panel. This type of operation is used to eliminate errors, of less than .5 volts per lead, caused by the voltage drop through the power leads to the load.

Voltage Programming of Output Voltage – Where the output voltage of the Power Supply is controlled by a 0 - 5 volt voltage source connected to the programming terminals, instead of by the front panel VOLTAGE control.

Resistance Programming of Output Voltage – Where the output voltage is controlled by a variable resistance (0 – 5000 Ω) connected to the programming terminals, instead of by the front panel VOLTAGE control.

Voltage Programming of Current – Where the output current is controlled by an external voltage source connected to the programming terminals.

Several "Operational Examples" are given in this section of the Manual to help you become more familiar with the controls and various programming methods. It may also be helpful if you read the "Circuit Description" and examine the Schematic before you operate this Power Supply.

OPERATING PROCEDURES

Examine the rear panel terminals (the screws must be tight) before you operate the Power Supply. Initially, this instrument is programmed for local sensing and front panel power output. It will be necessary to change the rear panel connections to operate in other modes. Wiring instructions for other configurations are presented in the "Examples" later in this section. Always operate the Power Supply in the following sequence.

1. Check the rear panel terminals for proper setup.
2. Press the PWR switch to ON. The meter will light.
3. Press the VOLT pushbutton, and adjust the COARSE and FINE VOLTAGE controls for the desired output voltage.
4. Short the output terminals.
5. Set the DC ON/STANDBY switch to DC ON.
6. Press the AMP pushbutton, and adjust the CURRENT control for the desired output current limit level.
7. Set the DC ON/STANDBY switch to STANDBY.
8. Remove the short and connect the load.
9. Set the DC ON/STANDBY switch to DC ON.

NOTES ON OPERATION

The following notes are provided as a general guide and will not satisfy every application. Therefore, it may be necessary to experiment for optimum results. CAUTION: Turn the AC power off before you change jumper clip positions.

WIRE RATING

Always select a wire sufficient in size to carry the current that would flow should the load short circuit. Refer to the wire rating chart (Table I) on Page 72.

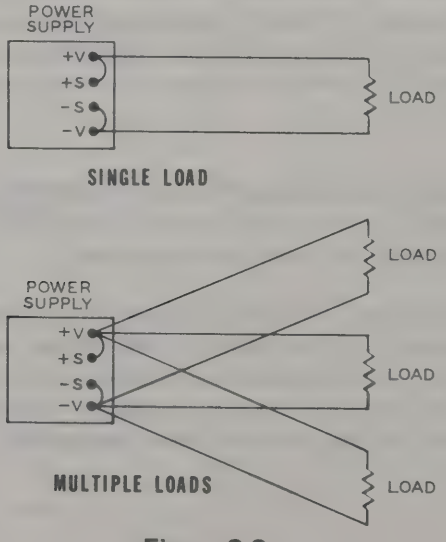


Figure 3-3

LOAD CONNECTIONS

If more than one load is connected to the Power Supply, use a separate pair of wires for each load and connect them directly to the Power Supply (See Figure 3-3).

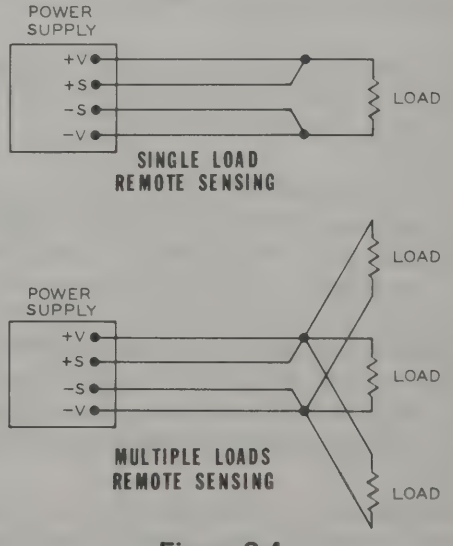


Figure 3-4

When remote sensing is used, connect each lead to a common point as close to the load as possible. Connect the sense leads to the same common point as shown in Figure 3-4.

LOAD DECOUPLING

To reduce high frequency mutual coupling between multiple loads fed from the same power supply, connect a decoupling capacitor across each pair of load leads at the common supply point. The high frequency impedance of the capacitors must be lower than the wire impedance. In addition, the capacitor lead length must be as short as possible.

GROUND SYSTEM

Often it is desirable, or necessary, to reference the Power Supply to ground potential. To avoid ground loop problems, there must be only one ground return point. One side of the supply line should be considered the DC common point. [If it is a positive supply, the DC common point is the negative (-V) terminal.]

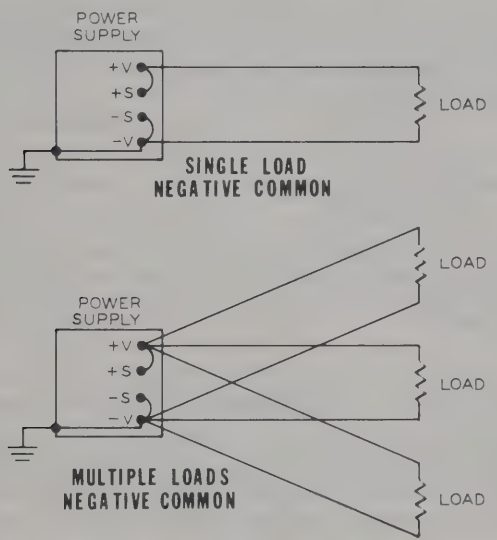


Figure 3-5

With single and multiple loads that are isolated from ground, the DC common should be grounded at the point where the sense lead is connected. Figure 3-5 shows the ground method with local sensing, and Figure 3-6 illustrates the ground method with remote sensing.

If one of the loads (in a multiple load system) is already referenced to ground, use that point as the DC common. Figure 3-7 illustrates the various configurations.

NOTE: Use a separate Power Supply for each grounded load. Ground loops generally occur when there is more than one connection of the DC common (+ or -) to earth (power line) ground, or when the common connections in a multiple load circuit are not all returned to one common point. Any "circulating" ground currents that then occur can produce noise in the DC circuit(s).

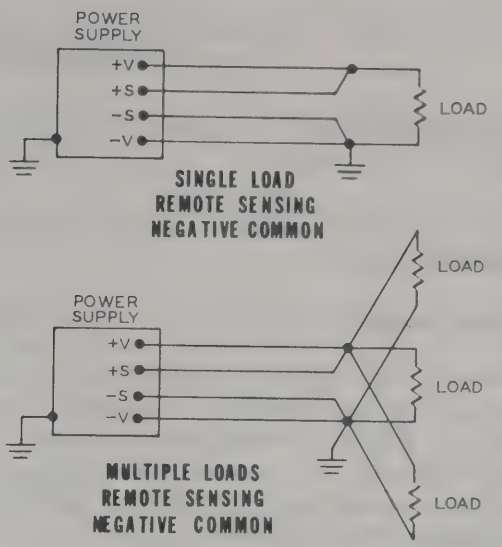


Figure 3-6

Whenever two or more Power Supplies are used together, they should be referenced to the same DC common ground, as you would for multiple loads.

NOTE: The -V terminal is coupled to chassis ground through a 0.1 microfarad capacitor. This must be taken into consideration with many applications; such as where earth (power line) ground loops might be a problem, or where the Power Supply is used for floating operation in high impedance circuits.

Two-wire shielded cable (as might be used for sense leads) must be grounded at only one end.

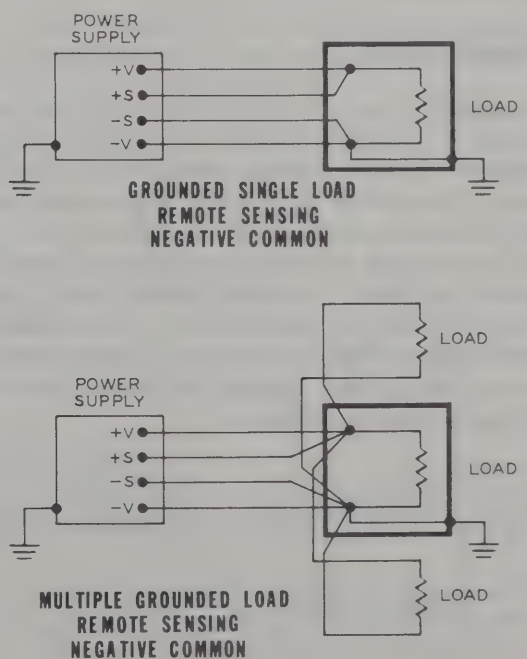


Figure 3-7

OPERATIONAL EXAMPLES

Figure 3-8

EXAMPLE #1

Local Sensing

Terminals 2 and 9 on the rear panel barrier strips are used to monitor the load voltage for feedback to the voltage regulator. With local sensing, the voltage is monitored at the Power Supply. If the front panel binding posts are connected to the load, install the four jumper clips to the two barrier strips as shown in Figure 3-8. If the load is connected to the barrier strips at terminal #3 (-V) and terminal #10 (+V), install the four jumper clips as shown in Figure 3-9. CAUTION: Whenever the load is connected to the barrier strips, always use terminals #3 and #10 (not #2 and #9).

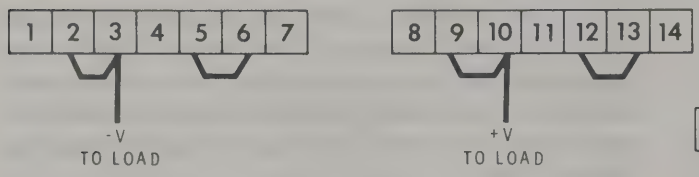


Figure 3-9

EXAMPLE #2

Remote Sensing

In applications where the load is remote from the Power Supply, it is best to monitor the voltage at the load for optimum regulation. Connect the load to the front binding posts or to terminals #3 and #10, as shown in Figure 3-10. Wire size must be large enough to insure a drop of less than 0.5 volts per lead at the load current drawn. Refer to "Wire Loading" on Page 72. Connect the sense leads to the power leads at the load. Use a twisted-pair or a coaxial cable for the sense leads to reduce stray noise pickup. Note that the jumper clips between terminals #5 and #6 and terminals #12 and #13 are not removed.

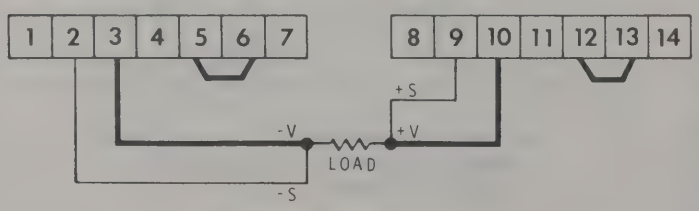


Figure 3-10

EXAMPLE #3

Voltage Programming Of Output Voltage

Remote control of the output voltage is easily accomplished with a 0 to 5-volt source. An input of 0 volts will produce a 0-volt output from the Power Supply while a 5-volt input will produce the rated maximum output from the Power Supply. Any input level between 0 and 5 volts will produce a proportional output level. Keep in mind that a programming signal with a fast rise time will produce some overshoot in the output level. The front panel VOLTAGE control is disabled in this program mode.

CAUTION: Programming voltages in excess of 5 volts can cause the output to go approximately 30% higher than its rated output. This will not damage the Power Supply, but it is not recommended as ripple will be excessive and regulation will be poor.

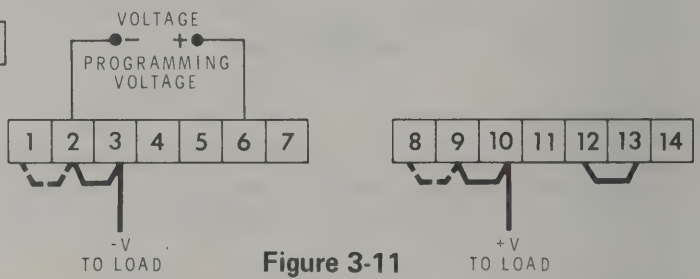


Figure 3-11

Refer to Figure 3-11 for a typical voltage programming setup. Remove the jumper clip from between terminals #5 and #6. Then connect the voltage source to terminals #2 (negative lead) and #6 (positive lead). Use a twisted wire pair or a coaxial cable to reduce noise pickup. All other jumper clips remain installed. Connect the load to either the front panel binding posts or to terminals #3 and #10 (as shown). NOTE: For local sensing of the front panel binding posts, the sense jumper clips must be connected to terminals #1 and #2, and terminals #8 and #9.

EXAMPLE #4

Resistance Programming Of Output Voltage

Output voltage can be programmed by an external control with a variable resistance from 0 to 5000 ohms. A zero resistance will produce a zero output level, while a resistance of 5000 ohms will produce the rated maximum output from the Power Supply. Any program resistance between 0 and 5000 ohms will produce a proportional output level. The front panel VOLTAGE control is disabled in this program mode.

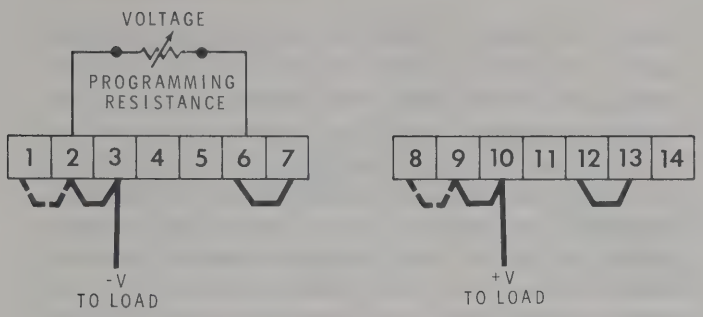


Figure 3-12

CAUTION: A programming resistance greater than 5000 ohms can cause the output to go approximately 30% higher than rated output. This will not damage the Power Supply, but it is not recommended as ripple will be excessive and regulation will be poor.

Refer to Figure 3-12 for a typical resistance programming setup. Remove the jumper clip from between terminals #5 and #6 and connect it between terminals #6 and #7. Connect the program control between terminals #2 and #6 with a twisted wire pair or a shielded cable to reduce noise pickup. All other jumper clips remain installed. Connect the load to either the front panel binding posts or terminals #3 and #10 (as shown). NOTE: For local sensing of front panel binding posts, the sense jumper clips must be connected to terminals #1 and #2, and terminals #8 and #9.

After the Power Supply has been set up for programmed resistance, it must be calibrated to the external control. To calibrate your Power Supply, perform the following steps. NOTE: This will not affect normal calibration or operation.

1. Position the controls and switches as indicated:

   PWR switch – Off (out).

   VOLT switch – On (in).

   AMP switch – Off (out).

   DC ON/STANDBY switch – STANDBY (down).

   CURRENT control – Fully counterclockwise.

   VOLTAGE control – Disregard (control disabled).

2. Insert the line cord plug into the proper power outlet and depress the PWR switch. The meter will light.

3. Allow the Power Supply 30 minutes to warm up before you begin calibration.

4. Remove the six screws from the top cover and remove the top cover.

5. Turn the front panel CURRENT control to the center of rotation.

6. Adjust the external program resistance to maximum (5000 ohms).

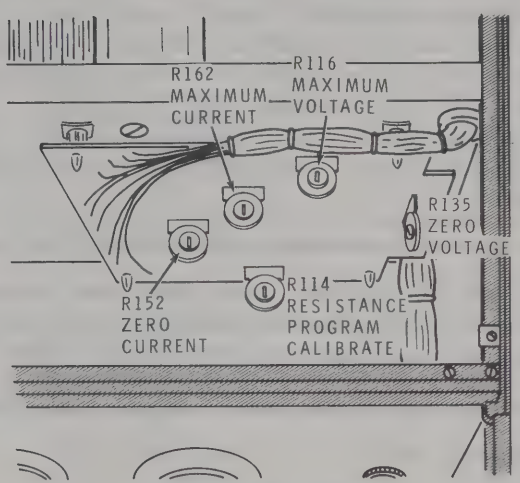


Figure 3-13

7. Refer to Figure 3-13 and adjust R114, the Resistance Program Calibrate control, for a 30-volt indication on the Power Supply meter.

8. Switch the Power Supply off and disconnect the line cord plug.

9. Reinstall the top cover.

The Power Supply is now calibrated to the external program resistance.

EXAMPLE #5

Voltage Programming Of Load Current

Load current limiting can be controlled by an external voltage source. The relationship between the current-limiting level and the external voltage applied is 1 ampere/1 volt.

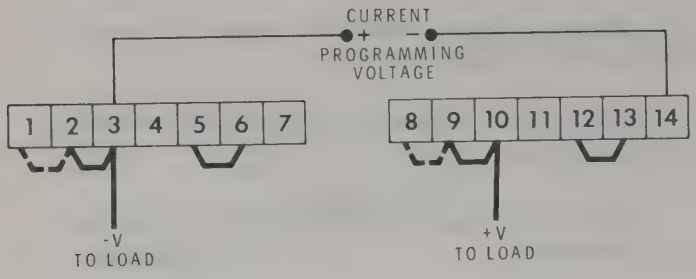


Figure 3-14

Figure 3-14 shows a typical setup with the load connected to terminals #3 and #10. However, the front panel binding posts can be used when the two sense jumper clips are reconnected to terminals #1 and #2, and terminals #8 and #9. The positive programming voltage is connected to terminal #3 and the negative to terminal #14. The front panel CURRENT control must be positioned fully counterclockwise. If it is not, there will not be a 1 to 1 relationship between current limiting and the programming voltage.

CAUTION: Output current can be programmed beyond the rated level. If this is allowed to continue for more than a few seconds, the driver and power transistors will overheat and fail.

EXAMPLE #6

Series Operation (Voltage Doubler)

Two Heathkit Power Supplies of the same voltage and current rating can be connected in series to produce a voltage of up to twice the rating of a single Power Supply. The two units operate in a master-slave configuration and the meter indications of both units must be added together for correct output voltage. However, either the master or slave unit can be used to indicate the correct current level.

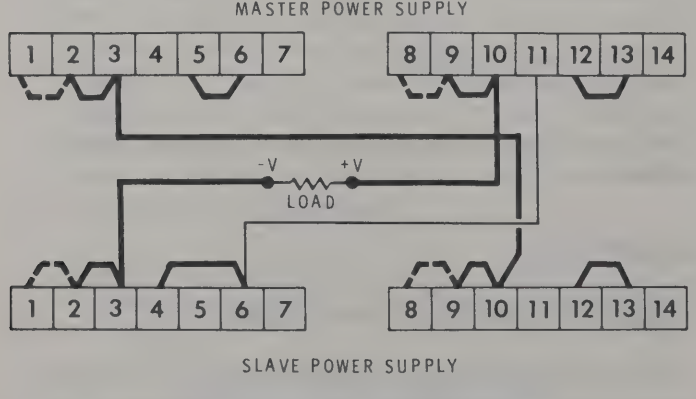


Figure 3-15

Figure 3-15 shows a typical series setup with the load connected to terminals #3 of the slave unit and #10 of the master unit. If the front panel binding posts are used, reconnect the sense jumper clips to terminals #1 and #2, and terminals #8 and #9 of both Power Supplies. Note that the jumper clip between terminals #5 and #6 has been removed on the slave unit and a jumper wire connected between terminals #4 and #6. Control interface is supplied through the wire connected between terminal #6 of the slave unit and terminal #11 of the master unit. The front panel CURRENT control on the slave unit must be turned fully clockwise to allow the master unit full control of current limiting.

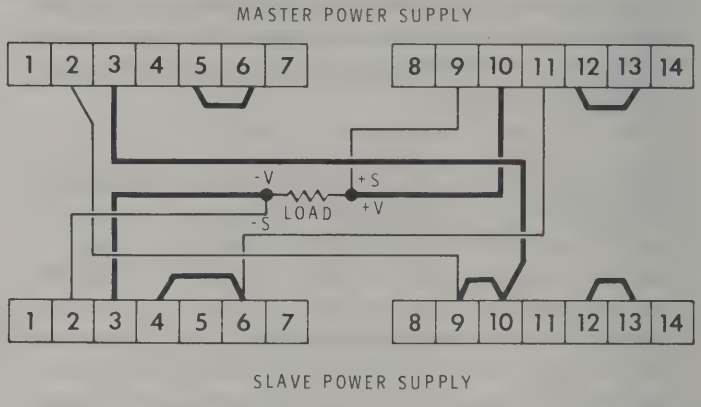


Figure 3-16

Figure 3-16 shows the correct method for connecting remote sense leads to the load. Note that the master negative sense terminal is connected to the slave positive sense terminal and the sense jumper clip remains connected between terminals #9 and #10 on the slave unit.

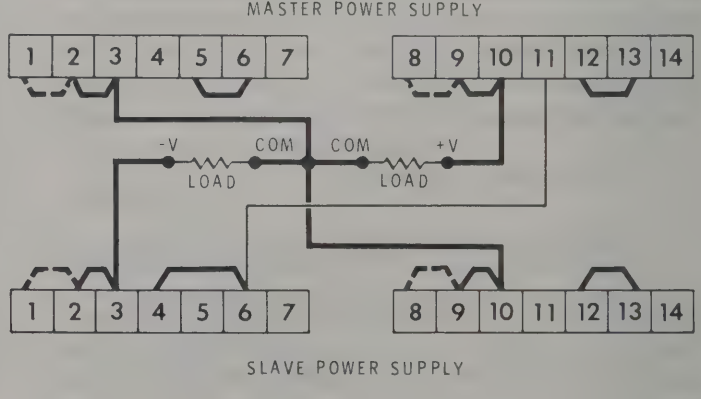
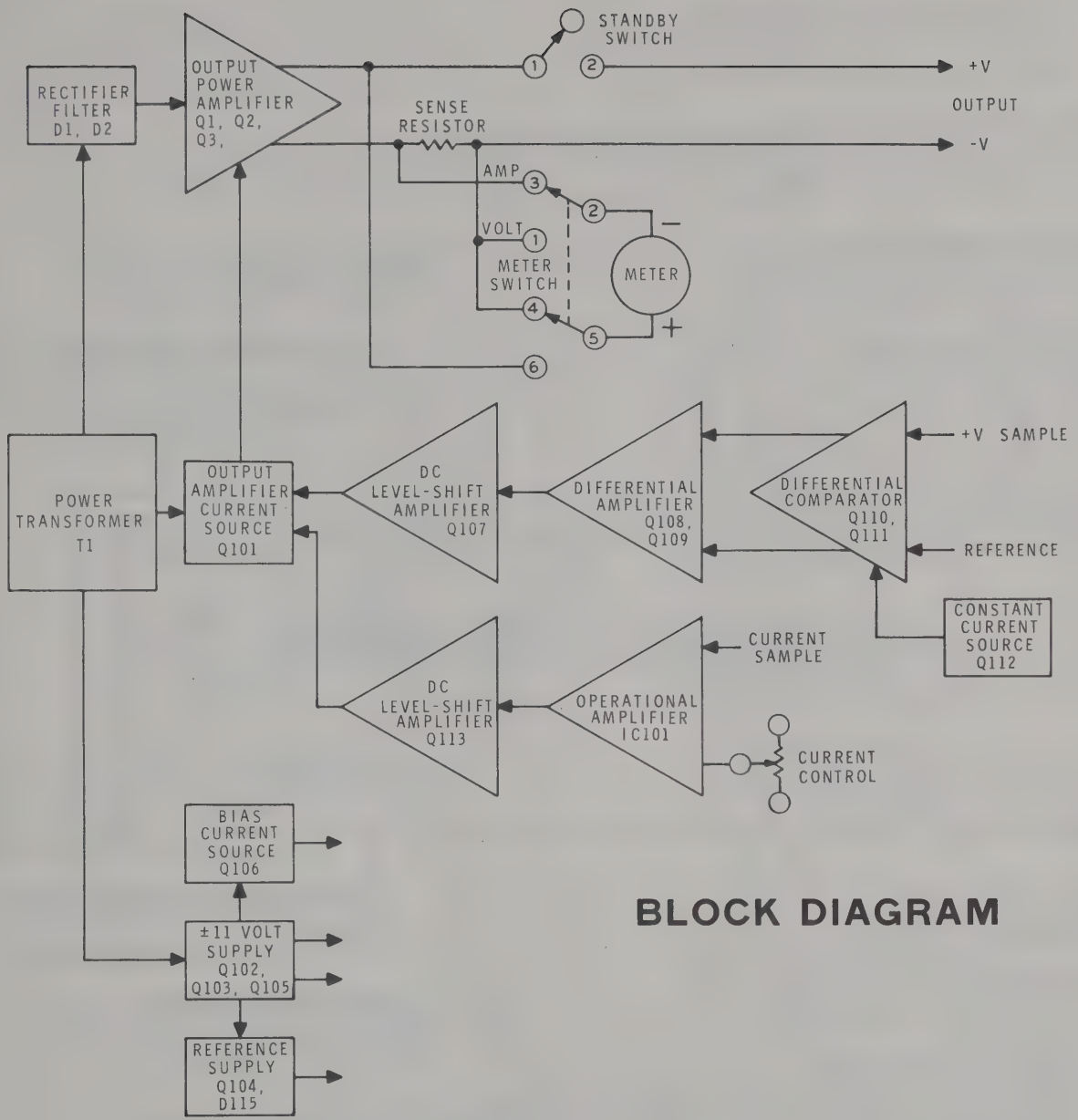


Figure 3-17



BLOCK DIAGRAM

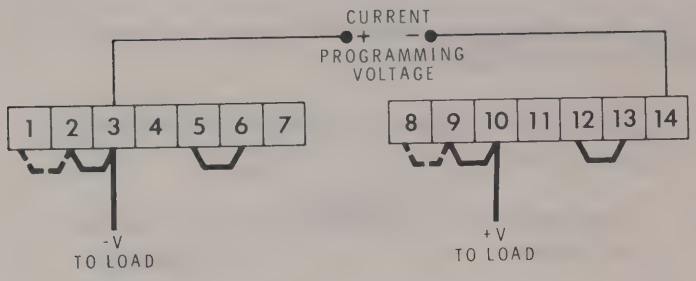


Figure 3-14

Figure 3-14 shows a typical setup with the load connected to terminals #3 and #10. However, the front panel binding posts can be used when the two sense jumper clips are reconnected to terminals #1 and #2, and terminals #8 and #9. The positive programming voltage is connected to terminal #3 and the negative to terminal #14. The front panel CURRENT control must be positioned fully counterclockwise. If it is not, there will not be a 1 to 1 relationship between current limiting and the programming voltage.

CAUTION: Output current can be programmed beyond the rated level. If this is allowed to continue for more than a few seconds, the driver and power transistors will overheat and fail.

EXAMPLE #6

Series Operation (Voltage Doubler)

Two Heathkit Power Supplies of the same voltage and current rating can be connected in series to produce a voltage of up to twice the rating of a single Power Supply. The two units operate in a master-slave configuration and the meter indications of both units must be added together for correct output voltage. However, either the master or slave unit can be used to indicate the correct current level.

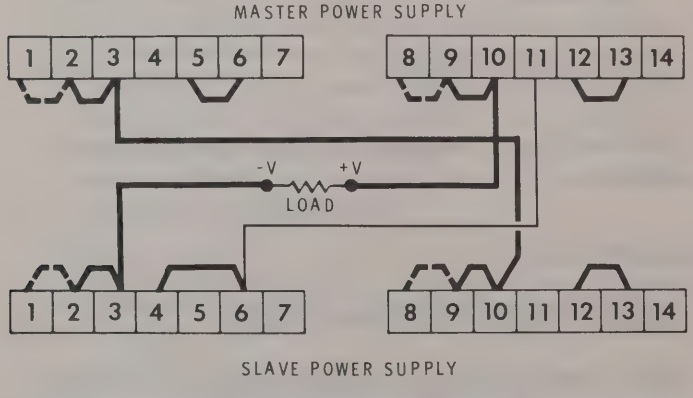


Figure 3-15

Figure 3-15 shows a typical series setup with the load connected to terminals #3 of the slave unit and #10 of the master unit. If the front panel binding posts are used, reconnect the sense jumper clips to terminals #1 and #2, and terminals #8 and #9 of both Power Supplies. Note that the jumper clip between terminals #5 and #6 has been removed on the slave unit and a jumper wire connected between terminals #4 and #6. Control interface is supplied through the wire connected between terminal #6 of the slave unit and terminal #11 of the master unit. The front panel CURRENT control on the slave unit must be turned fully clockwise to allow the master unit full control of current limiting.

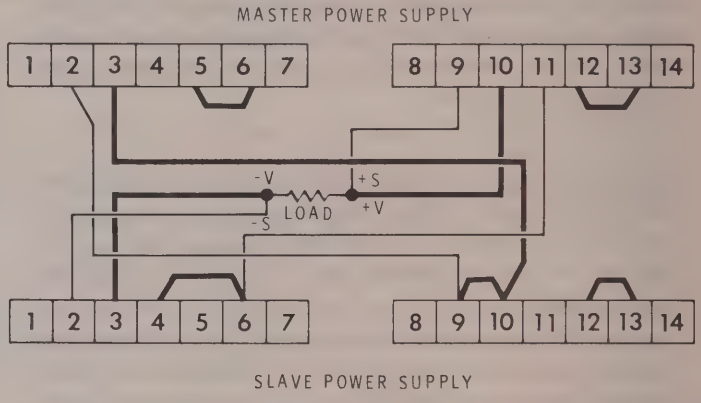


Figure 3-16

Figure 3-16 shows the correct method for connecting remote sense leads to the load. Note that the master negative sense terminal is connected to the slave positive sense terminal and the sense jumper clip remains connected between terminals #9 and #10 on the slave unit.

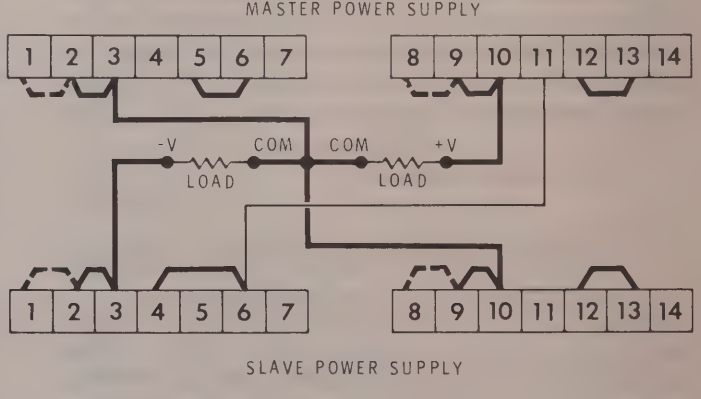


Figure 3-17

55

Insert Foldout/Map Here

WIRE LOADING

Table I provides the necessary data to connect your load to the Power Supply and maintain specified regulation. The "maximum current rating" is based on a single insulated copper wire with a wire temperature rise of approximately 60°C. Ambient temperature may be as high as 40°C. For two wires (twisted or bonded), use 80% of the maximum current rating specified. Wire lengths greater than 25 feet should have additional filtering added at the load. The "voltage drop constant" is based on a maximum voltage drop of 0.5 volts across one lead of the load wires, and a maximum wire temperature of 120°C. The following "Examples" illustrate its use.

EXAMPLES:

1. A load current of 10 amperes is to be carried over a distance of 50 feet.

CURRENT (AMPS) X DISTANCE (FEET) = VOLTAGE DROP CONSTANT

$$10 \times 50 = 500$$

The 10 ampere current indicates that you should use 20 gauge or larger wire. However, the voltage drop constant indicates that 8 gauge or larger must be used.

2. A load current of 5 amperes is to be carried, and 14 gauge wire is available.

$$\frac{\text{VOLTAGE DROP CONSTANT}}{\text{CURRENT (AMPS)}} = \text{LENGTH (FEET)}$$

$$\frac{156.3}{5} = 31.25$$

The load can be up to 31.25 feet away from the Power Supply.

3. The load is 25 feet from the Power Supply, and 22 gauge wire is available.

$$\frac{\text{VOLTAGE DROP CONSTANT}}{\text{LENGTH (FEET)}} = \text{CURRENT (AMPS)}$$

$$\frac{22.73}{25} = 0.91$$

A load current of up to 0.91 amperes can be carried.

TABLE I
LOAD WIRE RATING CHART

AWG WIRE GAUGE NUMBER	MAXIMUM CURRENT* (AMPS)	VOLTAGE DROP CONSTANT CURRENT (AMPS) X LENGTH (FEET)
24	4.7	17.61
22	9.3	22.73
20	14.7	36.50
18	21.3	76.92
16	27.3	97.09
14	42.7	156.3
12	53.7	247.5
10	73.3	381.7
8	97.3	681.2

*Bases on EIA Standard RS-214.

IN CASE OF DIFFICULTY

INTRODUCTION

This part of the Manual will help you locate and correct any difficulty which might occur in your Power Supply. This information is divided into two sections. The "General" section contains suggestions in the following areas:

A. Visual checks and inspection.

B. Precautions to observe when bench testing.

C. Locating and correcting both the cause and the effect of a difficulty.

The second section consists of a "Troubleshooting Chart." This chart calls out specific problems that may occur and lists one or more conditions or components that could cause each difficulty. The capacitor C numbers, transistor Q numbers, and the diode D numbers, are identified in this chart by the same numbers that are used on the Schematic Diagram. "Circuit Board X-Ray Views" (page 85) are also provided to help you locate the component and test points.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to "Customer Service" information inside the rear cover of the Manual. Your Warranty is located inside the front cover.

GENERAL

VISUAL CHECKS

1. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many difficulties can be eliminated by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Reheat any doubtful connections and be sure all the wires are soldered at places where several wires are connected.

2. Check the circuit board to be sure there are no solder bridges between adjacent connections. Remove any solder bridges that may exist.

3. Be sure the transistor and integrated circuit is in the proper location (correct part number and type number). Be sure that each transistor lead is positioned properly and has a good solder connection to the foil. Check the integrated circuit for proper positioning and good contact at all pin connections.

4. Check capacitor values carefully. Be sure the proper part is wired into the circuit at each capacitor location. For example, it would be easy to mistake a .001 μF capacitor for a 100 pF capacitor. Always check the polarity of electrolytic capacitors to be sure the "+" lead is installed at the correct location.

5. Check each resistor carefully. It would be easy, for example, to install a 1200 Ω (brown-red-red) resistor where a 220 Ω (red-red-brown) resistor is called for. A resistor that is discolored, cracked, or shows any sign of bulging would indicate that it is faulty and should be replaced.

6. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

7. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something you have consistently overlooked.

8. Check all component leads connected to the circuit board. Make sure the leads do not extend through the circuit board and make contact with other connections or parts.

BENCH TESTING

WARNING: The full AC line voltage and high voltage DC is present at several points in the Power Supply. Be careful to avoid personal shock when you work on the Power Supply. Refer to Figure 1-1 on Page 58.

- Be cautious when you test the transistors and integrated circuit. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage and current than are other circuit components.

- Be careful so you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short out a bias or voltage supply point, it may damage one or more components.

- Do not remove any components while the Power Supply is turned on.

- When you make repairs to the Power Supply, make sure you eliminate the cause as well as the effect of the trouble. If, for example, you should find a damaged resistor, be sure you find out what caused the resistor to become damaged. If the cause is not eliminated, the replacement resistor may also become damaged when the Power Supply is put back into operation.

- Refer to the "X-Ray Views," and the "Schematic" to locate the various components.

- Use a high impedance voltmeter to make any voltage measurements.

- Use the –V or –SENSE terminal for circuit ground when you make any voltage measurements.

- Always check the ±11 volt supply for proper level before you attempt to troubleshoot this instrument.

- Connect the rear panel jumper clips for normal operation, front panel output.

TROUBLESHOOTING CHART

PROBLEM	POSSIBLE CAUSE
Blows fuse.	1. Switch SW2 incorrectly wired. 2. Diodes D1 or D2 incorrectly connected or shorted to chassis. 3. Filter capacitors C2 or C3 wired backwards.
No output, meter not illuminated.	1. Fuse open. 2. Power transformer incorrectly wired.
No output, meter illuminated.	1. Output shorted, check wiring. 2. Control R152 improperly adjusted. 3. Barrier strip jumper clips improperly installed. 4. Transistor Q107 or Q113 shorted. 5. Meter, switch SW4, or SW5 incorrectly wired. 6. Diodes D103, D114, or D118 defective. 7. Diode D11 open. 8. Diode D21 shorted. 9. Defective voltage regulator circuit if output goes high when jumper clip across terminals 12 and 13 is removed. (Turn power off before you remove jumper clip.)
Voltage high, meter off scale.	1. Transistor Q107 open. 2. Transistor Q1, Q2, or Q3 shorted. 3. Diode D131 defective. 4. Barrier strip jumper clips improperly installed. 5. Defective voltage regulator circuit if output goes low when jumper clip across terminals 12 and 13 is removed. (Turn power off before you remove jumper clip.)
No current control.	1. Integrated circuit IC101 installed incorrectly or defective. 2. Diode D151 reversed or open. 3. Control R152 adjusted incorrectly. 4. Q113.

PROBLEM	POSSIBLE CAUSE
Oscillation on the output with no load.	1. Any of the following RC circuits defective: R121-C121, R126-C126, R128-C128, or R129-C129. 2. Any of the following capacitors defective: C11, C117, C122, or C141. 3. R152 improperly adjusted.
Oscillations on the output with a load. Current limiting set higher than load current.	1. Any of the following RC circuits defective: R121-C121, R126-C126, R128-C128, or R129-C129. 2. Any of the following capacitors defective: C11, C117, C122, or C141. 3. Many types of loads, especially circuits incorporating active devices, will react with the complex output impedance of the Power Supply to produce oscillations; usually of low amplitude and high frequency. Adding bypass capacitors to the load circuit, or in some manner changing the impedance characteristics should eliminate the oscillations.
Oscillations on the output with a load. Current limiter is regulating the load current.	1. Capacitors C11, C151, or C152 defective. 2. Resistor R154 open or incorrect value.

SPECIFICATIONS

Specifications determined by NEMA standards (PY1-1972) after 30-minute warmup period.

Output	Voltage: 0-30 VDC. Current: 0 – 3A.
Load Regulation	Voltage: ±0.05%, +1 mV. Current: 0.10%, +3.5 mA.
Line Regulation	Voltage: ±0.05%, +1 mV. Current: ±+0.10%, +1 mA.
Ripple and Noise	1 mV rms. 0.03% of full rated output peak-to-peak.
Temperature Coefficient (10°C to 40°C ambient)	Voltage: ±(0.01% +1 mV)/°C. Current: ±(0.05% +1 mA)/°C.
Stability	Voltage: ±(0.01% + 1 mV)/hr. Current: ±(0.05% + 1 mA)/hr.
Load Transient Recovery	For a load ⩽3A, output voltage shall be in regulation band within 50 μS.
Overshoot	Zero overshoot when switching power on or off (Standby switch on).
Output Protection	Up to 200V against positive applied voltages. 10A diode clamp for negative applied voltages. Indefinite short circuit protection.

Load Protection	<1.5 VDC change with open sense leads.
Meter Accuracy	±3% of full scale.
Programming Frequency Response	DC to 100 Hz, ±2 dB.
Programming Transient Response	0.1 mS for low to high load current changes, 1 mS for high to low load current changes. Load resistance must be less than 10 times rated output voltage divided by rated output current.
Programming Mode	Voltage: 0 to 30 VDC with 0 to 5.0 VDC applied. 0 to 30 VDC with 0 to 5000 Ω external resistor. Current: 0 to 3A with applied voltage of 1 volt/ampere.
Power Requirements	110-130 V, 50/60 Hz, 200 watts. (220-260 V by changing internal switch and fuse.)
Fuse	120V Operation: 3-ampere, 125 V. 240V Operation: 1-1/2-ampere, 250 V.
Dimensions	5.5" high, 15" wide, and 13.5" deep. (13.97 cm high, 38.1 cm wide, 33.02 cm deep).
Weight	30 lbs. (13.6 kgs.).

The Heath Company reserves the right to discontinue products and to change any specifications at any time without incurring any obligation to incorporate new features in products previously sold.

FEATURES

Voltage Control	Front panel variable, zero to full output, coarse and fine controls.
Current Control	Front panel variable, zero to 100% control.
Operating Modes	Constant voltage, constant current, auto-series, dual-tracking, and auto-parallel.
Programming Modes	Voltage control of voltage, resistance control of voltage, and voltage control of current.
Outputs	Front panel: +V, -V, and chassis ground binding posts. Rear Panel: +V, -V, chassis ground, remote sense, and parallel and series programming barrier strip terminals.
Output Protection	Output protected against circuit shorts and applied voltage.
Load Protection	Load protected from open sense leads.
Specifications	Determined by NEMA standards PY1-1972.

VERIFICATION

True evaluation of the performance characteristics of a power supply require careful testing methods. The following general procedures are presented if you wish to verify the Specifications.

1. Terminate all test leads with spade-type lugs or solder connections. Alligator clips and other similar connectors may inject undesirable contact resistance.

2. Use twisted wire-pairs or shielded cable for test leads. Stray magnetic fields can introduce unwanted signals.

3. Check for system-generated noise and ripple after hookup. Ground loops generate undesirable current paths.

4. Connect all test instruments at the power supply sense terminals. Erroneous readings can be obtained if the measurements are made at the load.

CIRCUIT DESCRIPTION

This Power Supply consists of six basic circuits: The power source, the output amplifier current source, the output amplifier, the voltage regulator, the current regulator, and the display circuit. Each circuit will be described in its operation and relationship to the other circuits. Refer to the Schematic Diagram (fold-out from Page 89) and the Block Diagram (fold-out from Page 72) as you read the following description.

POWER SOURCE

Transformer T1 has a dual primary winding that can be switch selected to allow operation from either a 120 VAC or a 240 VAC, 50/60 Hz power source. The secondary windings supply the AC voltages required to power the various circuits.

Power for the output amplifier is supplied by the first winding (green, green-yellow, and green leads) through the rectifier filter. The AC voltage is first rectified by diodes D1 and D2. Then it is filtered by capacitors C2 and C3, and bleeder resistors R2 and R3, to produce the required 40 VDC level.

The second transformer winding (blue, blue-yellow, and blue leads) is connected to the output amplifier current source. (This circuit will be described later.) The winding also supplies voltage to the meter lamps, which are connected across the winding and are in series with resistor R1.

Diodes D111, D112, D116, and D117 rectify the AC voltage from the third transformer winding (brown, brown-black, and brown leads) to produce a +20 VDC and a −20 VDC source for the +11 VDC and −11 VDC supplies. Capacitor C111 filters the +20 VDC source. Resistors R111 and R112, diode D113, and transistor Q102 comprise a constant current source. The voltage drop across D113 is constant, due to its zener action. This forces the voltage across R112 and the base-emitter junction of Q102 to be constant. The constant voltage across R112 produces a constant current at the emitter of Q102. Therefore, the collector current of Q102 is constant. This constant current source maintains a constant current flow through zener diode D114 to insure a constant bias voltage at the base of pass transistor Q103. Thus, regulated +11 volts is produced at the output of Q103 for use in the current and voltage regulators.

The constant current from the collector of Q102 is also coupled through resistor R113 to zener diode D115, and produces a constant voltage that is used as a reference by the voltage regulator. Control R116 adjusts the reference voltage level to limit the maximum output voltage level. This voltage is also coupled to the base of transistor Q104 as a reference. The +11 volts is passed through resistors R114 and R115 to develop a constant current at the emitter of Q104. The constant current produced at the collector of Q104 is used in the resistance programming mode of operation, for control of the voltage regulator. Control R114 sets the current level for a calibrated output.

Capacitor C115 filters the -20 VDC source and resistor R117 supplies current to zener diode D118. This produces a constant voltage reference to the base of pass transistor Q105. Thus, a regulated -11 volts is produced at the output of Q105 for use in the current and voltage regulators.

Transistor Q106 is wired as a negative current source. A constant voltage is developed across zener diode D119 and resistor R118 at the base of Q106. This produces a constant voltage across emitter resistor R119. Thus, the collector becomes a constant current sink for the output amplifier drivers to insure that the output transistors (Q2, Q3) are biased off when the power supply is adjusted for a zero output level.

The three remaining secondary transformer windings are not used in this power supply.

OUTPUT AMPLIFIER CURRENT SOURCE

This circuit supplies drive current to the output amplifier. Its constant current output is diverted by the current and voltage regulators to maintain the desired power supply output level. The individual control circuits will be described later.

Diodes D101 and D102 rectify the AC voltage from the second secondary transformer winding (blue, blue-yellow, and blue), while capacitors C101 filters the DC voltage produced. The center tap of the transformer winding is connected to the output amplifier collectors to insure that this current supply is always at a higher DC voltage level than the output amplifier. Zener diode D103 and transistor Q101 form a constant current source which supplies current to the output amplifier.

OUTPUT AMPLIFIER

The output amplifier supplies the output power, and consists of driver transistor Q1 and power transistors Q2 and Q3. The power transistors are connected in parallel, with emitter resistors to force current sharing. Driver transistor Q1 is connected to the power transistors in a Darlington configuration for increased current gain. Resistors R12 and R14, and capacitor C11 provide high frequency stabilization.

Current from the output amplifier current source (Q101) is amplified by Q1 and coupled to the base of the power transistors. This current determines the voltage and maximum current passed by the power transistors. As previously mentioned, the output amplifier current source operates at a higher DC voltage level than does the output amplifier. This insures that up to four power supplies can operate in parallel with complete voltage and current control.

Diode D22 is connected between the +V output and the positive sense to insure that the output level will not exceed the component power limitations in case the sense line should open, or is not connected. Diode D154 serves the same function for the negative sense line.

VOLTAGE REGULATOR

The voltage regulator maintains the output voltage level, and consists of three primary circuits: A differential comparator that compares a sample of the output voltage to a reference voltage, a differential amplifier to amplify the error signal from the comparator, and a DC level-shift amplifier to sink current from the output amplifier current source.

Transistors Q110 and Q111 comprise a differential voltage comparator, while transistor Q112, resistor R136, and zener diode D131 form a constant current source for the comparator. Control R135 balances the current flow so that a zero reference voltage will produce a zero output voltage.

The reference voltage is coupled to the base of Q110 through voltage control R21/R22 on the external resistance program terminal. Diodes D121 and D122 provide voltage protection for the comparator. Divider resistors R142 and R143 supply a sample of the output voltage (+V) to the base of Q111. Assuming the base voltages to Q110 and Q111 are equal, the collector current of each transistor is also equal. If the reference voltage is decreased, the collector current of Q110 will decrease and force an equal increase of Q111 collector current. A change in current flow through resistor R133 and R134 will cause a voltage change at the collectors of Q110 and Q111. This voltage is coupled to the bases of the differential amplifier Q108, Q109. Diode D123 provides voltage protection for transistors Q108 and Q109.

The collector of Q111 is connected to the base of Q108. A decrease in the collector voltage of Q111 will cause an increase in the base current and, therefore, the collector current of Q108. Thus, a decrease in base voltage results in an increase in collector voltage. This voltage is coupled to the DC level-shift amplifier, Q107. Emitter voltage is held constant by the differential operation of transistors Q108 and Q109.

DC level-shift amplifier Q107 operates as a current sink for the output amplifier current source. As the collector voltage of Q108 increases, the base current of Q107 increases. This increases the collector current, which sinks more current from the output amplifier current source. As current to the output amplifier is reduced, the output voltage level is reduced until there is no longer a voltage difference at the differential comparator.

High frequency stabilization is provided in the voltage regulator through RC networks R121-C121, R126-C126, R128-C128, and R129-C129.

CURRENT REGULATOR

Current limiting is controlled by the current regulator which contains two basic circuits: an operational amplifier, which compares a reference voltage to the voltage drop across the current sense resistor R158; and a DC level-shift amplifier to sink current from the output amplifier current source.

Reference diodes D161 and D162 supply a constant negative voltage to the maximum current control, R162, and then to current control R23. This reference voltage is coupled to pin 3 (positive input) of comparator IC101. The output current produces a voltage drop across sense resistor R158 that is coupled to pin 2 (negative input) of comparator IC101. If the voltage at pin 2 is more negative than the voltage at pin 3, the output at pin 6 of the comparator is positive. The output is negative if pin 3 is more negative than pin 2. Diode D151 couples only positive voltage error signals to the DC level-shift amplifier Q113. Resistor R154 and capacitor C152 in the feedback loop control gain and frequency response in the comparator. Control R152 is adjusted for a zero output with a balanced comparator input. Diodes D152 and D153, and resistors R155 and R156 provide voltage protection at the input of the comparator.

As the output current exceeds the level set by the current control, the comparator generates a positive voltage that is coupled to the base of DC level-shift amplifier Q113. This increases the base current, which in turn increases the collector current and sinks current from the output amplifier current source. A lower current level to the output amplifier will limit the current the output amplifier can supply.

DISPLAY CIRCUIT

Switch SW4 selects the input to the meter. When pressed, it connects the positive and negative sense terminals to the meter through R24. In the out (released) position (SW5 pressed in), it connects the meter across sense resistor R158 through resistor R157.

COMPONENT IDENTIFICATION

This section of the Manual contains "Circuit Board X-Ray Views," and "Component Identification Charts." The X-Ray Views show the location of the components. The Charts illustrate the components and list their characteristics.

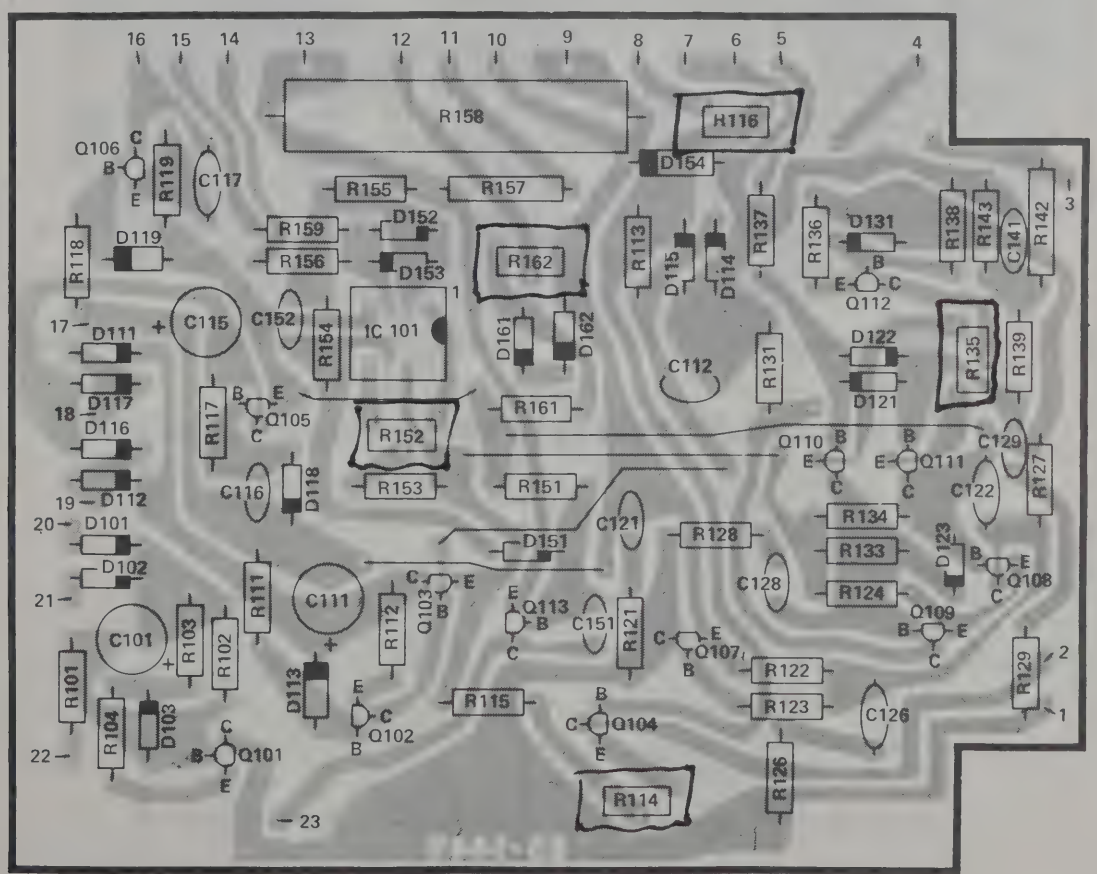
CIRCUIT BOARD X-RAY VIEWS

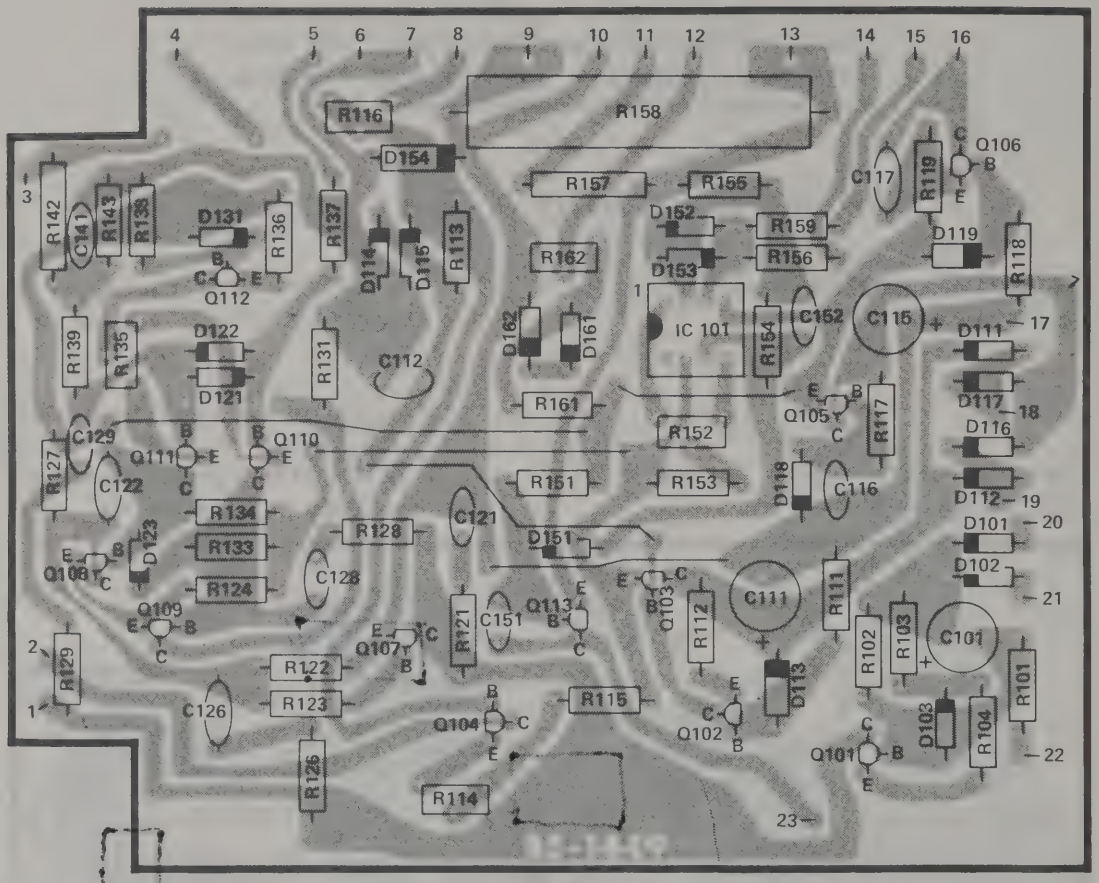
NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R155, C101, etc.) on the "X-Ray View."

B. Locate this same number in the "Circuit Component Number" column of the "Parts List."

C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.

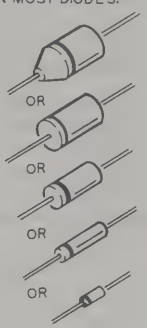




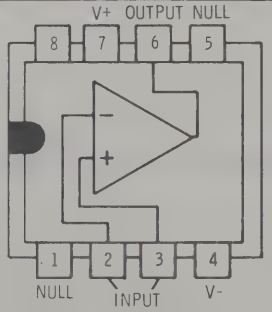
(Viewed from foil side)

COMPONENT IDENTIFICATION CHARTS

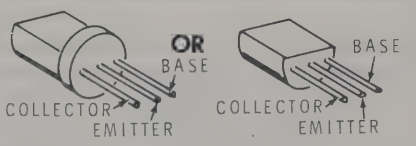
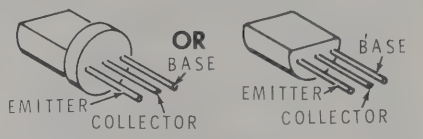
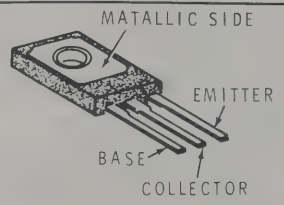
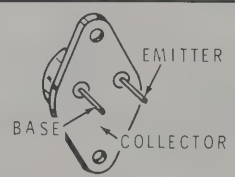
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	DESCRIPTION	DIAGRAM
D121, D122, D123, D151, D152, D153, D162	56-56	1N4149	DIODE 10mA, 75V	NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES. 
D114, D118	56-57	1N716A	ZENER DIODE 12mA, 12V	
D103	56-58	1N709A	ZENER DIODE 25mA, 6.2V	
D113	56-59	1N750A	ZENER DIODE 20mA, 4.7V	
D119, D131, D161	56-63	MZ500-10	ZENER DIODE 1mA, 5.6V	
D115	56-71	1N825A	T. C. ZENER DIODE 7.5mA, 6.2V	
D1, D2	57-42	3A1	DIODE 3A, 100V	
D22, D101, D102, D111, D112, D116, D117, D154	57-65	1N4002	DIODE 1A, 100V	
D11, D21	57-89	MR1122	DIODE 10A, 200V	

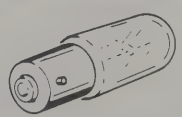
INTEGRATED CIRCUIT

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	BASE DIAGRAM (TOP VIEW)
IC101	442-22	741	

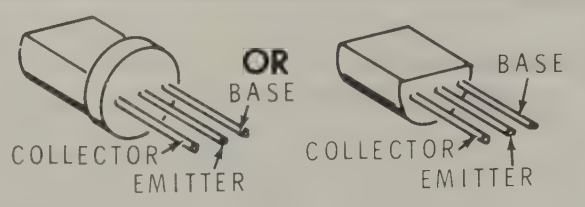
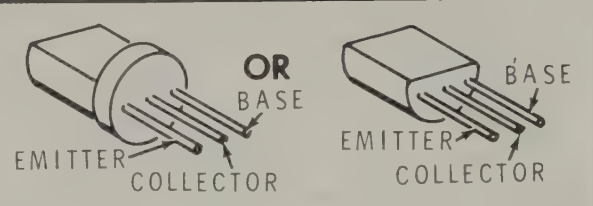
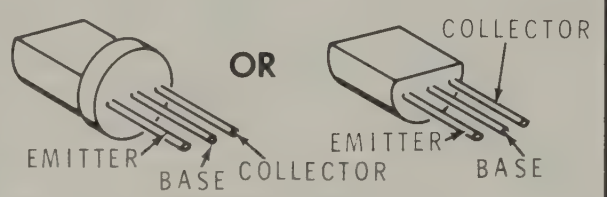
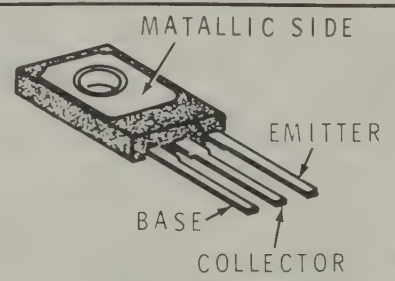
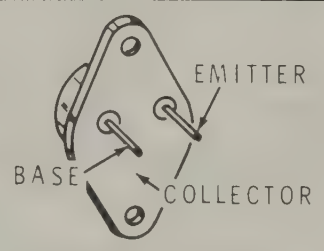
TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	LEAD DIAGRAM
Q110, Q111 MATCHED PAIR	117-12	HEATH PART ONLY	
Q102, Q104, Q105, Q108, Q109	417-201	X29A829	
Q106, Q107, Q113	417-294	MPSA42	
Q101	417-295	MPSL51	
Q103, Q112	417-801	MPSA20	
Q1	417-264	SJE608	
Q2, Q3	417-833	2N6306	

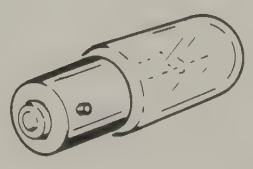
BULBS

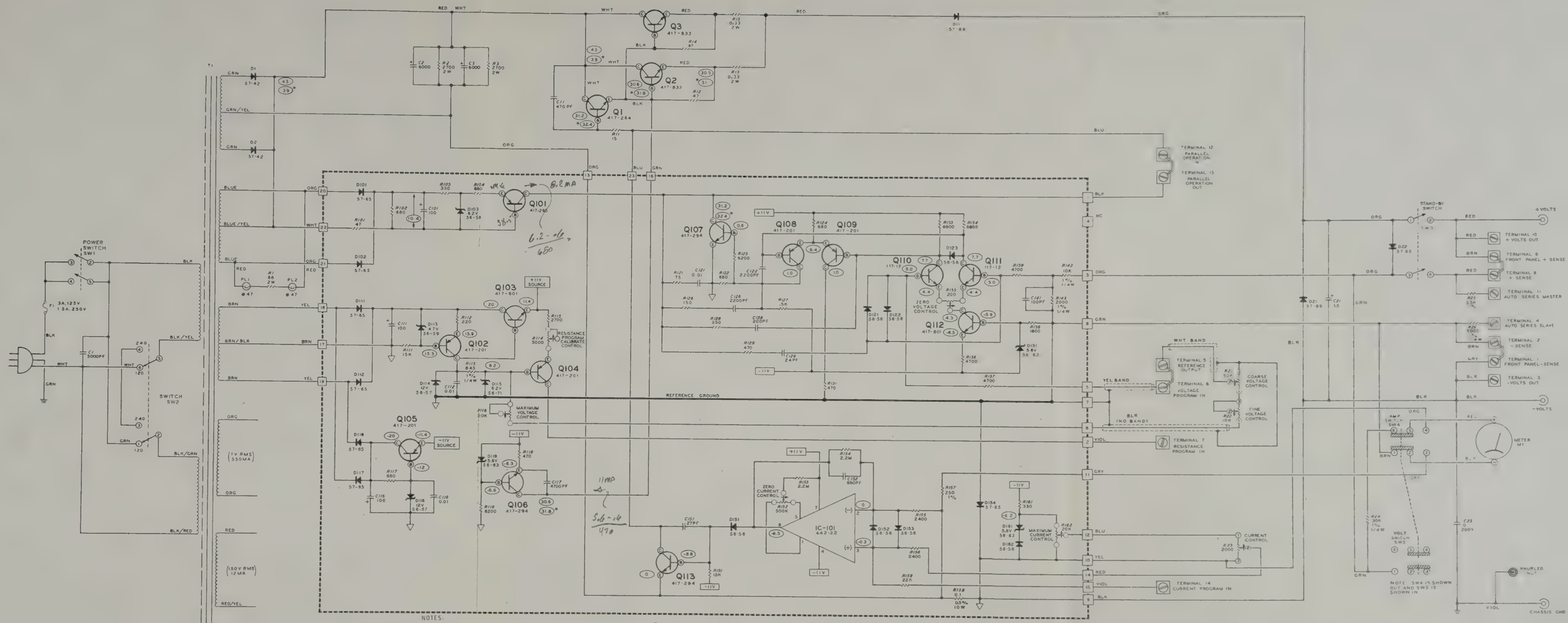
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	DIAGRAM
PL1, PL2	412-1	#47	

TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	LEAD DIAGRAM
Q110, Q111 MATCHED PAIR	117-12	HEATH PART ONLY	
Q102, Q104, Q105, Q108, Q109	417-201	X29A829	
Q106, Q107, Q113	417-294	MPSA42	
Q101	417-295	MPSL51	
Q103, Q112	417-801	MPSA20	
Q1	417-264	SJE608	
Q2, Q3	417-833	2N6306	

BULBS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	DIAGRAM
PL1, PL2	412-1	#47	



NOTES:

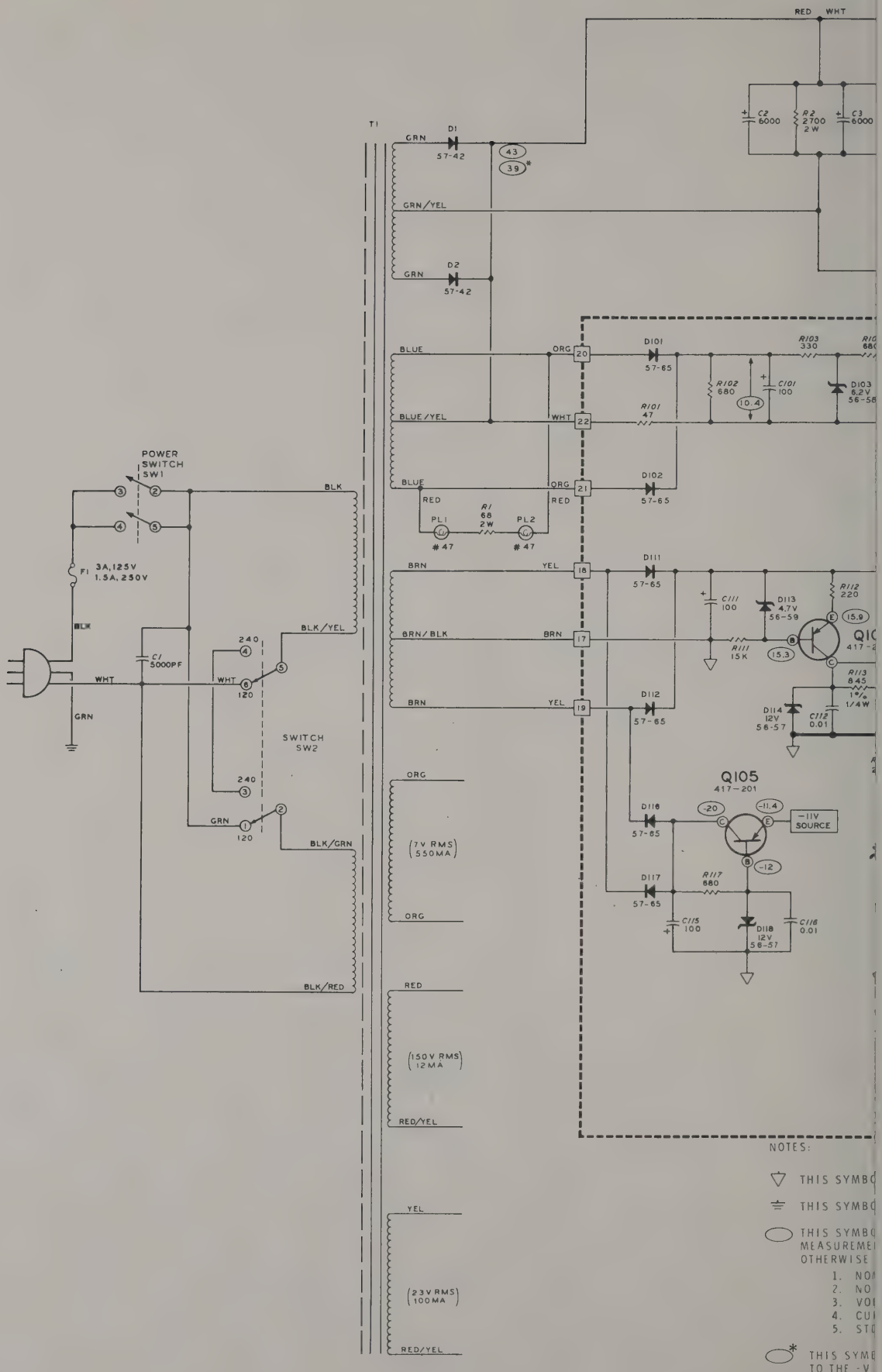
- THIS SYMBOL INDICATES CIRCUIT GROUND.
- THIS SYMBOL INDICATES CHASSIS GROUND.
- THIS SYMBOL INDICATES A DC VOLTAGE MEASUREMENT TO THE -V TERMINAL, UNLESS OTHERWISE SPECIFIED. CIRCUIT CONDITIONS INCLUDE:
  1. NOMINAL LINE VOLTAGE OF 120 VAC (240 VAC).
  2. NO LOAD.
  3. VOLTAGE CONTROLS FULLY CLOCKWISE.
  4. CURRENT CONTROL FULLY CLOCKWISE.
  5. STD-BY SWITCH TO DC ON.
- THIS SYMBOL INDICATES A DC VOLTAGE MEASUREMENT TO THE -V TERMINAL UNDER FULL RATED LOAD CONDITIONS.
- THIS SYMBOL INDICATES A CIRCUIT BOARD WIRE CONNECTION.
- ARROW INDICATES CLOCKWISE ROTATION.

ALL RESISTORS ARE 1/2-WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000).

ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS MARKED OTHERWISE.

CIRCUIT COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS.
0-99 CHASSIS MOUNTED PARTS.
100-199 CIRCUIT BOARD PARTS.

SCHEMATIC OF THE HEATHKIT® 30V, 3A POWER SUPPLY MODEL IP-2710



NOTES:

▽ THIS SYMBO

⏚ THIS SYMBO

⬭ THIS SYMBO MEASUREME OTHERWISE

1. NO
2. NO
3. VO
4. CU
5. ST

⬭* THIS SYME TO THE -V

□ THIS SYME CONNECTI

FOR PARTS REQUESTS ONLY

- Be sure to follow instructions carefully.
- Use a separate letter for all correspondence.
- Please allow 10 - 14 days for mail delivery time.

DO NOT WRITE IN THIS SPACE

INSTRUCTIONS

- Please print all information requested.
- Be sure you list the correct **HEATH** part number exactly as it appears in the parts list.
- If you wish to prepay your order, mail this card and your payment in an envelope. Be sure to include 10% (25¢ minimum, $3.50 maximum) for insurance, shipping and handling. Michigan residents add 4% tax.

  Total enclosed $_____
- If you prefer COD shipment, check the COD box and mail this form. COD ☐

NAME _____

ADDRESS _____

CITY _____

STATE _____ ZIP _____

The information requested in the next two lines is not required when purchasing nonwarranty replacement parts, but it can help us provide you with better products in the future.

Model # _____ Invoice # _____

Date Purchased _____ Location Purchased _____

LIST **HEATH** PART NUMBER	QTY.	PRICE EACH	TOTAL PRICE
TOTAL FOR PARTS			
HANDLING AND SHIPPING			
MICHIGAN RESIDENTS ADD 4% TAX			
TOTAL AMOUNT OF ORDER			

SEND TO: **HEATH COMPANY**
BENTON HARBOR
MICHIGAN 49022
ATTN: PARTS REPLACEMENT

Phone (Replacement parts only): 616 982-3571

THIS FORM IS FOR U.S. CUSTOMERS ONLY
OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR

CUT ALONG DOTTED LINE

FOR PARTS REQUESTS ONLY

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- Please allow 10 - 14 days for mail delivery time.

DO NOT WRITE IN THIS SPACE

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CITY _____

STATE _____ ZIP _____

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TOTAL FOR PARTS			
HANDLING AND SHIPPING			
MICHIGAN RESIDENTS ADD 4% TAX			
TOTAL AMOUNT OF ORDER			

SEND TO: **HEATH COMPANY**
BENTON HARBOR
MICHIGAN 49022
ATTN: PARTS REPLACEMENT

Phone (Replacement parts only): 616 982-3571

THIS FORM IS FOR U.S. CUSTOMERS ONLY
OVERSEAS CUSTOMERS SEE YOUR DISTRIBUTOR

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

Schlumberger

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.